TELE-TECH

Formerly the TELE-communications TECH-nical Section of
ELECTRONIC INDUSTRIES

Editorial Contents

NOVEMBER, 1947

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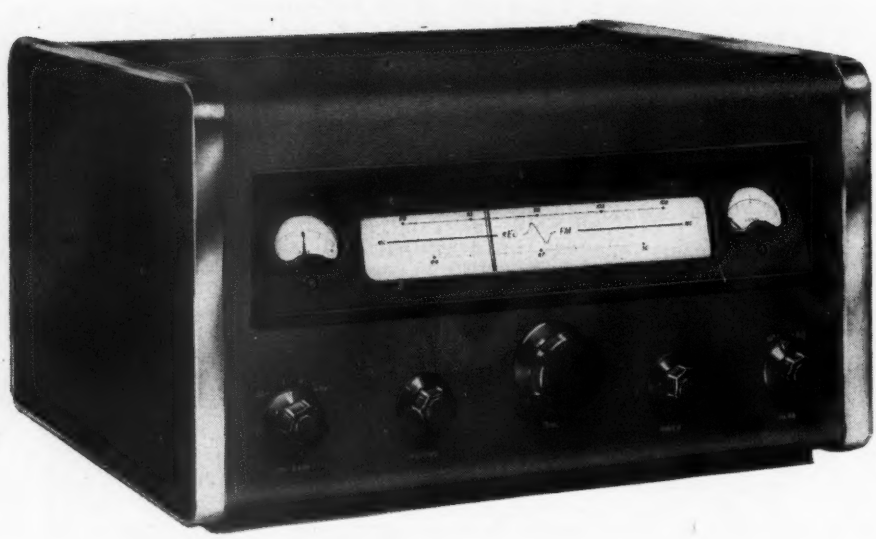
REL FM RECEIVERS



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O. H. CALDWELL, EDITOR ★ M. CLEMENTS, PUBLISHER ★ 480 LEXINGTON AVE., NEW YORK (17), N. Y.

LOW BAND FOR FM RELAY may be one of arguments advanced to keep the 42-50 mc bracket for frequency modulation. Experience with the new FM network has shown the superior carrying power of the low-band signals when used for relaying programs between stations. Future of FM network operation, it will be pointed out, may depend upon continuance of low band for relaying, making it also available for local FM broadcasts as well.

RADIO DEADLINE. It is a paradox worthy of note that a service with an accent on speed fails to recognize the power of radio. Observing this lassitude, FCC set aside only 4 channels in the 152-162 mc for the newspaper field. The ponderous railroads, by contrast, have received 60 authorizations. Only one daily in all U.S. is using radio to speed up copy and pictures from news origins.

RADIOTELEPHONES ON TRAINS. At long last we hear that at least three U.S. railroads have installed radiotelephones in some of their crack trains. Europe led off years ago with such phone service, so it was only a matter of time when some American railroad would translate a technically sound idea into practical execution. Now passengers on speeding trains can call any telephone connected to the Bell system.

AN ENGINEERING BASIS for future allocations is one of the principal achievements of the Atlantic City conferences which set up bands of frequencies to be used internationally for every conceivable radio service. Heretofore, as most everyone knows, services merely "requested" allocations, which when allowed were entered on a master list. Henceforth allocations are to be made in accordance with the findings of the combined technical brains of the 78 countries that participated in the conferences—and then only within the bands allocated for the specific service seeking a spot in the spectrum. Something had to be done to make it possible for all those who want to use radio to live together in harmony and without interference. Now engineering has done just that.

MORE DOLLARS, MORE PATENTS—Once it was the general policy for corporations to pay their employed inventors "one dollar" for each patent filed and assigned to the company. But recently a more liberal attitude has been taken by management in the radio-electronic field, so that now, with many corporations, inventors' honorariums range from $100 to $150 per patent and up. This higher rate of payment has proven a marked stimulus to creative effort. And the corporation acquires more (and better) inventions and patents that are the very foundation-stones of modern technical manufacturing.

MICROWAVE RADIO RELAYS FOR TV will play three important roles in the new art. (1) Microwave links can connect cities and stations, creating networks. (2) Microwave relays serve importantly to pick up outlying events and bring picture and sound into the TV broadcasting transmitter. (3) Microwave links can tie the central transmitter in with surrounding satellite stations, thus widening the primary program area beyond that imposed by the horizon.

REGULATORY SITUATION PUZZLING—All three of above vital services to television can be performed within the same frequency range. With beam control, plenty of channel space is available, as beams are interleaved and utilized without interference. Thus engineering problems are being solved. But the regulatory picture is not so clear, for the FCC has not yet indicated its approval of microwaves as above, except for experimentation. Still, the Commission has already shown its friendly attitude toward television. Certainly if it wants the TV tree to grow, these microwave roots and branches must be allowed to expand freely.

Edison's Remedy for Today's Troubles

"THERE IS NOTHING WRONG WITH THIS COUNTRY THAT GOING BACK TO WORK WOULDN'T CURE"

—Thomas A. Edison's philosophy.

As interpreted by Frank M. Tait, lifelong associate of the inventor, in address to the Edison Pioneers of which he is president, during New York's celebration of 100th anniversary of Edison's birth.

Impulse Noise Generator for Testing FM Receivers

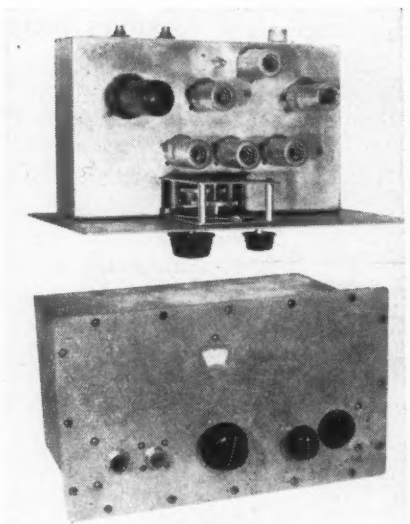
By JOSEPH C. TELLIER, Project Engineer
Research Div. Philco Corp., Philadelphia

Simple equipment for predicting susceptibility of a receiver to "pops" and "clicks" and determining effectiveness of limiter action

• Recent analyses of the effect of impulse noise on FM receivers have brought into sharp relief the nature of the problem involved. It has been shown that under certain conditions, which in practice are random and uncontrollable, an FM detector which is ideal by definition will provide a definite and annoying response to impulse noise. This response occurs despite the fact that an ideal detector is defined to be completely insensitive to amplitude modulation. The reason for the response obtained is simply that the impulse noise may cause an equivalent frequency modulation of the resultant IF signal applied to the detector. When this modulation contains audible components, the detected output will contain audible noise.

Because of the fact that relatively large amplitude impulse noise also produces a high percentage of amplitude modulation, previous investigations have perhaps been somewhat beclouded. In the case of limiter circuits in particular, careless design of time constants will result in noise output similar in nature to the "pops" described by Smith and Bradley, even though there be no equivalent frequency modulation whatever. It is little wonder, then, that in the presence of audio noise output obtained from the use of electric drills, razors, etc., doubt has sometimes existed as to the efficacy of the limiter system.

With the impulse noise generator to be described, however, it is possible to predict whether "pops" or "clicks" will be obtained. If the



Top chassis and front views of Philco noise generator for testing FM receivers

generator is adjusted to produce clicks, which is to say simply that any equivalent frequency modulation contains negligible audio components, and with this adjustment in effect appreciable audible noise output results, then it is possible to say that the amplitude modulation rejecting portions of the circuit should be re-examined.

Before discussing the generator proper, it may be well to review briefly and simply the nature of "pops" and "clicks"* as discussed by Smith and Bradley.

Impulse noise, as exemplified by man-made interference, must be of relatively large amplitude compared with the desired signal being received *to be of importance;* but conversely, it is nearly always of relatively short duration, e.g., one half microsecond or less. On the other hand, the time constant of conventional commercial IF systems in FM receivers is relatively long, being determined by the bandwidth of the system. In particular, the narrower the pass band, the longer the time constant. When the number of stages and width of the pass band are carefully chosen with respect to both good performance and economic considerations, it may safely be said that the IF time constant will be considerably greater than the duration of the noise burst.

Under these conditions, the actual frequency of the noise burst will be of little importance as long as there are components which, upon conversion in the first detector, fall within or near the IF pass band. Because of the short duration of the noise burst, and the long IF time constant, there will be insufficient time to permit build-up in the IF system of components of appreciable amplitude corresponding to the actual noise frequency. Instead, remembering also the high noise amplitude presumed, the IF system will be shock excited and will proceed to "ring" at its own natural center frequency.

The duration of this ringing, as shown by Smith and Bradley, will in general be of the order of 3 or 4 time units, the actual value being a very slowly varying function of noise-to-signal ratio, number of IF stages, and bandwidth of the latter. A time unit is defined as the time corresponding to the half bandwidth of the over-all system in radians. For example, if

*David B. Smith and W. E. Bradley "Theory of Impulse Noise in Ideal FM Receivers". Proceedings of the I.R.E., October, 1946.

the IF system is 150 kc wide to the half power points, a time unit would be $t = \frac{1}{2\pi \times 75{,}000}$ seconds. Taking π time units as a convenient average value of ringing time, the latter would be given as

$$t_r = \frac{\pi}{2\pi \times 75{,}000} \cong 7\,\mu\text{secs}$$

During this period of approximately 7 μ secs after the occurrence of a noise burst, the total signal applied to the second detector may be considered to be made up of two components. The first of these is the desired signal, in general at a frequency differing from IF center frequency. The second is the ringing signal, greater in amplitude for the major part of the period, but always at center frequency.

Effect of Phase

The resultant of these two signals is one which begins at signal frequency, grows until it is dominated by the ringing or noise signal, and decays until control is again established by the desired signal. But here a very important fact must be remembered. This is simply that the detector is responsive to the instantaneous frequency, or rate of change of phase of the total applied signal. For this reason it becomes imperative to examine the phase of the resultant signal. And it is here that two possible conditions of output due to the application of a noise burst become apparent.

For descriptive purposes a vector diagram of signal, noise, and resultant may be drawn as in Fig. 1, in which the diagram is stopped at IF center frequency. At the time of initiation of the noise burst, the desired signal is assumed, as a first instance, to be somewhat higher than center frequency, and in the phase indicated by OS_1. A short time later, the signal vector, being higher in frequency, has advanced to OS_2, but the noise vector, at IF center has grown to ON_2. The resultant is then OR_2, the phase of which has moved backward from that of the signal alone, ϕ_1 to that of the resultant, ϕ_2. Somewhat later the noise vector is at its peak, ON_3, and the resultant is OR_3, having a

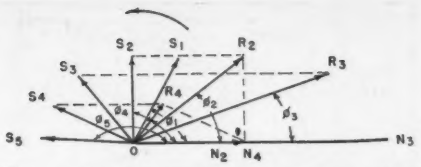


Fig. 1—Vector diagram of signal, noise burst, and total resultant voltage applied to detector under conditions leading to a click. The diagram is stopped on the center frequency of the IF system

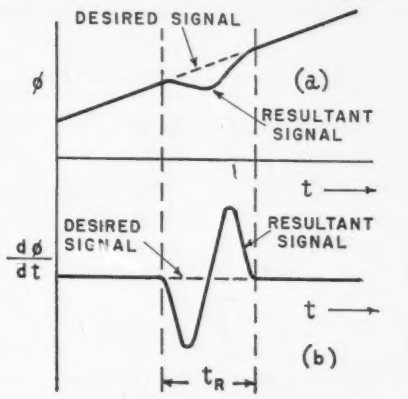


Fig. 2—Phase angle and time derivative of phase of desired and resultant signals, under click conditions

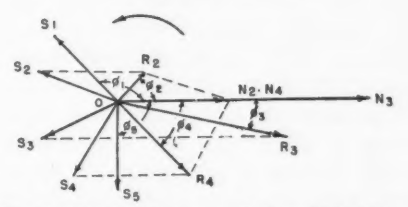


Fig. 3—Vector diagram of signals leading to a pop

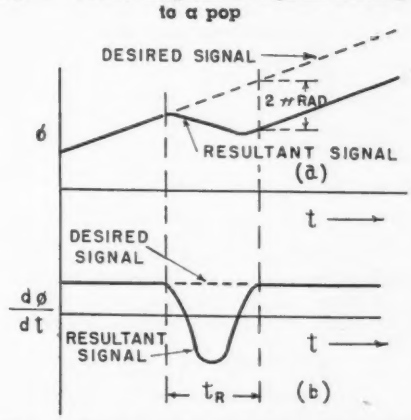


Fig. 4—Phase angle and time derivative of phase of desired and resultant signals, under pop conditions

phase angle of ϕ_3. As the signal vector proceeds through OS_4 to OS_5, the phase angle returns rapidly through ϕ_4 to that of the signal alone, ϕ_5. This variation in phase and the corresponding time derivative are depicted in Fig. 2.

The time derivative of phase, Fig. 2 (b) is representative of the audio output, neglecting de-emphasis, of the detector. Because of the fact that the area under the excursions from normal essentially cancels, and the total time t_r is short, negligible audible output results, as shown by a Fourier analysis of the output wave.

Without changing any factor but the relative position of the desired signal when the noise burst occurs, an entirely different result may be obtained. In Fig. 3, for example, the same conditions are shown except that the initial position of the desired signal vector OS_1 is taken as being near phase opposition with the noise burst. Under these conditions the phase angle of the resultant moves backward through the positions ϕ_1, ϕ_2, ϕ_3, ϕ_4 to ϕ_5, where it is again superficially the same as that of the signal, with one important exception. A complete cycle of the frequency of rotation of OS has been lost.

Diagnosing a "Pop"

The resulting phase curve, and the time derivative thereof, are shown in Fig. 4. In this case, because of the uncancelled area between the resultant $d\phi/dt$ curve and the unperturbed curve, a Fourier analysis does show appreciable audible output. This is the condition which has been termed a "pop". The basic and important fact is that between the two test conditions assumed, not one factor was changed except the timing or relative phase, of the noise burst. Yet in the second instance, an observer unaware of the nature of the phenomenon might well condemn the AM rejection characteristic of the system.

Two purposes are thus served by the development of a generator of impulse noise from which the type of output can be controlled. First, the ability of a detector to reject true amplitude modulation may be determined. Secondly, further investigation into the subject of "pops" and the practicability of preventing their occurrence may be more efficiently conducted.

The basic principle of the generator circuit finally conceived is extremely simple and leads to great reliability, but was not immediately obvious. Much thought was given to various methods of controlling the instantaneous phase relationship between signals of two different frequencies and characteristics (representing steady

carrier and burst of noise) before the possibility of deriving both from a single rf source occurred.

The method, though easily justified, is not obvious because it is known that the signal vector must be rotating with respect to the noise vector, and in fact must pass through phase opposition with the latter, to produce a "pop". However, it will be shown that this condition is readily obtained, even though both signals are derived from the same source.

In Fig. 5, the plate current components in the converter tube are shown in a typical case, wherein a noise burst is synthesized by merely amplifying the signal representing the desired carrier, and superimposing it on the latter for one half microsecond. The IF is assumed to be 10 mc, so that 5 cycles occur in this time. The center frequency of the IF system is assumed to be somewhat different.

Because of the relatively long time constant of the over-all IF system, the output at the end of the latter will not be as shown in Fig. 5. In the short time that the noise burst lasts, the output voltage cannot build up to the steady state condition which would result if the noise burst were many times longer. Hence the effect of the noise burst is merely to inaugurate the ringing of the IF system, which will continue for the greater portion of its duration at its own center frequency.

Phase Relationship

Because of the initial coincidence of several cycles of noise and signal, however, (Fig. 5) a definite and fixed phase relationship exists between the two, or in other words the timing of the noise burst build-up is completely controlled. If the phase relationships of Fig. 5 are made variable through 360°, the complete range of "pop" and "click" phenomena may be included. This is the basic principle of the generator, and from this point the details of the equipment may next be discussed.

Fig. 6 represents a block diagram of the complete unit. A signal from an external generator covering the FM band, and preferably capable of being frequency

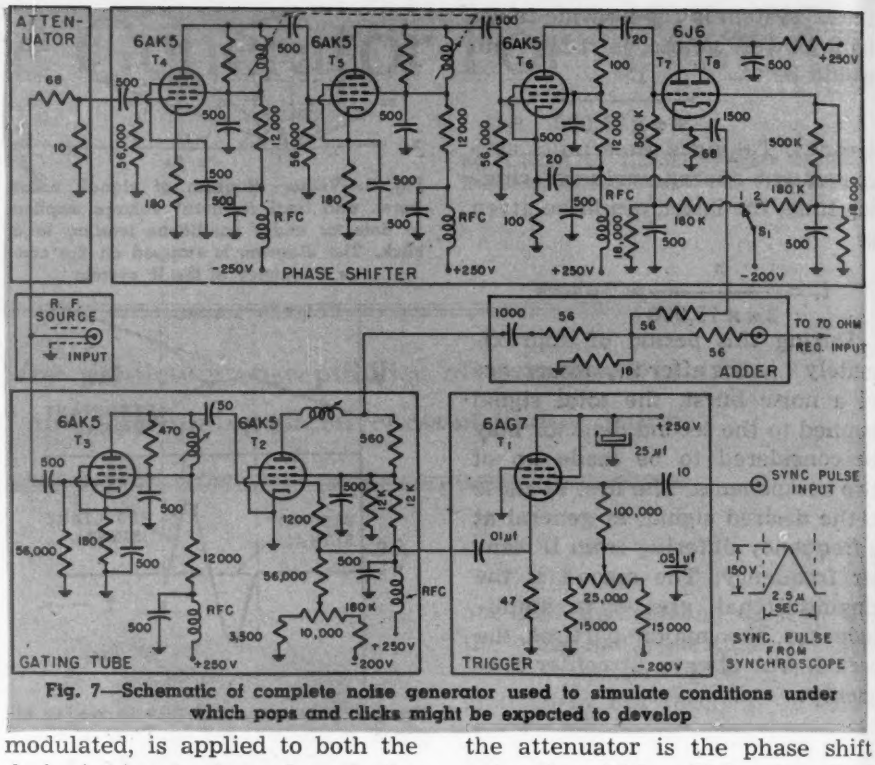


Fig. 7—Schematic of complete noise generator used to simulate conditions under which pops and clicks might be expected to develop

modulated, is applied to both the desired signal channel and the noise synthesizing channel. In the first of these an attenuator is inserted so that the noise-to-signal ratio may be established at any desired value. In the equipment built, this ratio was fixed at 10 to 1, but for greater versatility might well be made variable. Following

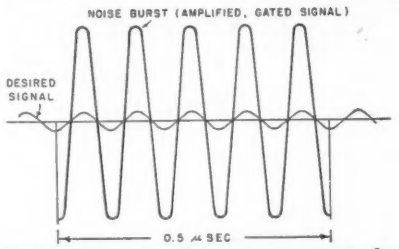


Fig. 5—Converter plate current waves due to synthetic noise burst and steady signal from same rf source. Signals in phase

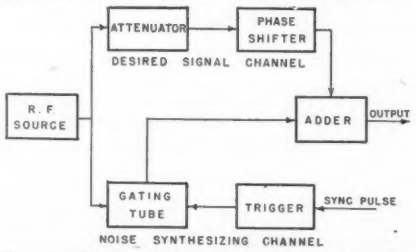


Fig. 6—Block diagram of Philco impulse noise generator

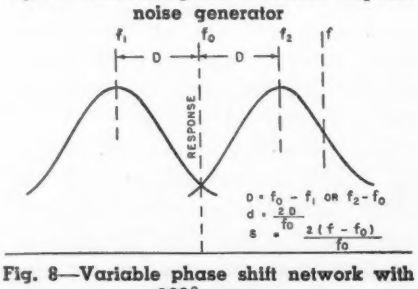


Fig. 8—Variable phase shift network with 180° range

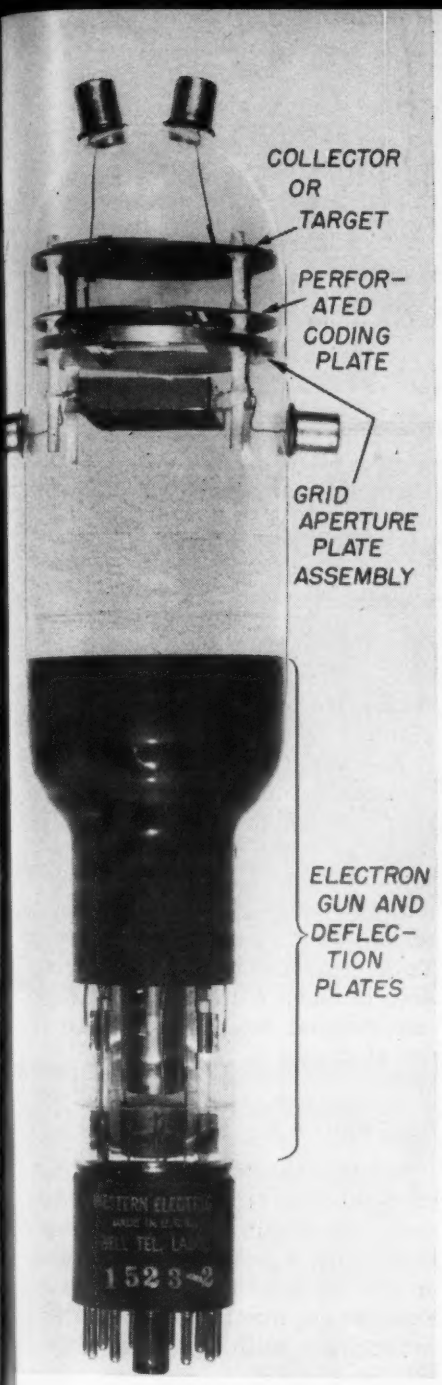
the attenuator is the phase shift network, which will be described later. It may be said here, however, that a complete range of phase shift is obtainable. The output from this stage is then applied to the adder.

In the noise synthesizing channel, the unattenuated generator output is applied to an amplifier stage which is gated at any desired repetition rate for one half microsecond intervals. The gating operation is obtained by means of a trigger forming network, driven by any suitable pulse. A standard synchroscope has been found convenient for this purpose.

Fig. 7 shows a complete schematic of the unit, and further description will be given with reference to this diagram. The desired signal channel is composed of tubes T4-5-6-7-8. Signal from the external FM generator is applied at the rf input point through the resistive network marked "attenuator" to the grid of T4. The latter, in conjunction with T5, forms a portion of the phase shift network. In this section, a continuously variable phase shift over a range of 180° is obtained in a simple manner by the use of two single tuned circuits. These are stagger tuned, and their adjustments are ganged so that they may be varied with constant center frequency spacing.

It is readily shown that when

(Continued on page 96)



This tube, especially developed by Bell Telephone Labs converts an AM signal to 7-digit coded pulses. An electron ray generated in the usual way scans across a single row of slots, depending on the height of the pulse sample

Advanced Pulse Code Modulation System

New vacuum tube of CR type simplifies coding process and permits development of 96-channel system using 7-digit code

● Pulse code modulation technics (as recently described*) are being advanced rapidly by the introduction of new methods and equipment. At a recent meeting in New York several features of the system were demonstrated to I.R.E. members. Of particular interest was a practical demonstration of music and speech quality that can be handled by the coded system with from one to 10 digits in the code unit. Speech reached the highest required commercial quality with a seven-digit code, with which 128 levels of amplitude can be separately handled in the reproduction of the voice waves.

As mentioned this system is well adapted for multiple channel operation using time sharing methods. During the demonstration transmission of voice and music was brought over telephone lines from the Bell Laboratories research buildings at Murray Hill, N. J., to the auditorium of the Engineering Societies building in New York city. A shared-time 12 channel system had been set up here. The individual code pulses were of approximately 1.5 microsecond duration, the seven pulses requiring about .01 millisecond each. The recurrence rate of each 7-pulse group in each channel therefore was about 8000 per second, giving a possible frequency range of 3500 cycles. The demonstration showed that this was entirely satisfactory for this service.

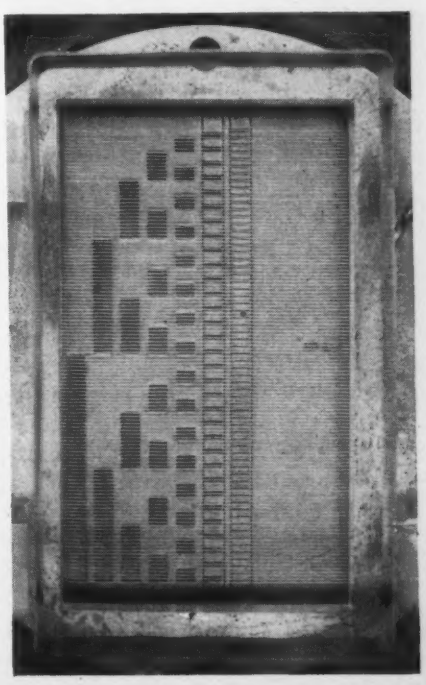
A feature of the demonstration was a simplification of the coding process by the use of a new tube of the cathode ray tube type, which has permitted the development of a 96-channel system of the seven-digit code type. Such a system must have a pulse capability of over 5 million accurately timed pulses per second.

All of the 128 codes available in the seven-pulse code-group are perforated in appropriate order, on a special target plate inside the tube. This plate is placed so that the beam of electrons can sweep across the seven elements of any one code-group. Which one it actually sweeps across is determined by the position of the beam, and this in turn is determined by the amplitude of the signal at the time of sampling.

If the beam goes through a hole in the perforated plate, the pulse is an "on" pulse; if the beam is blocked because there is no perforation at that point, it is an "off" pulse. The irregular pattern of "on-off" pulses carries the information concerning the amplitude sample to the receiving station.

(*Continued on page* 102)

Target assembly of the Bell Tel. Labs type 1523-2 tube as it appears to the electron ray, showing the alignment electrodes, one containing 128 horizontal slots between the grid wires of the grid aperture plate, with the coding plate behind it



*Tele-Tech, September 1947

WOR's Field Pick-Up Studio for Spot Broadcasts

Four transmitters, powered from bank of storage batteries, make mobile equipment independent of AC lines — Specially designed vehicle

• A streamlined broadcasting studio on wheels is the latest addition to WOR's Field Radio Department. It is designed to speed newscasters and engineers directly to the scene of important news breaks and special events throughout the New York Metropolitan area. From these random points, battery-powered transmitters relay program material to receivers at strategic locations; the receiver nearest the mobile studio takes over for reception. One receiver is located at WOR headquarters in mid-Manhattan, another at the transmitter site in Carteret, N. J., and a third at 444 Madison Avenue. Each receiver feeds a line which terminates in the field room at the WOR studios. The production engineer monitors the three lines and uses the one with the cleanest signal.

Transmitter Equipment

To complement the activities of the mobile studio, the WOR Special Facilities Department keeps constant watch on the latest news breaks and special events. A quick call to the mobile crew will enable it to whistle over to the scene of the news break and begin transmission immediately. In effect, WOR has an originating studio at any point in the Metropolitan area where important news events are likely to take place.

Four high-frequency transmitters housed in copper-lined compartments are used to handle any transmission problem. An FM transmitter operating in the 150 mc region is used for short transmission distances, i.e., within the immediate Metropolitan area. Operation at these higher frequencies is expected to eliminate signal bouncing. This latter difficulty was encountered in the 30-40 mc band and showed up as grid meter dips each time a lamp post was passed while the mobile unit took part in a parade.

A 25-28 mc AM transmitter is used for intermediate distances where high-frequency operation is impracticable. A third AM transmitter operating in the 1.5 to 3 mc band is used for longer distance transmission. On one occasion the mobile unit motored to a point on the New England coast to report flood damage. At the scene, a long wire was strung out from the truck to a nearby tree to serve as an antenna for the LF transmitter. A fourth transmitter is used as a spare.

Power supply for the various transmitters, receivers and associated equipment is obtained from a bank of twelve 6-volt batteries which provide an independent power supply where AC lines are not available. The battery bank is capable of delivering approximately 1800 ampere-hours—enough to enable the mobile studio to stay on the air for many hours at a stretch without outside power. Means for charging the batteries in place will consist of a motor-generator set when near an AC power source. Plans are under way to provide a trailer-borne gasoline driven, 110 v, 5 kw alternator. For long duration emergencies such as floods, forest fires, etc., the trailer will be hooked on to the studio truck as a mobile power plant.

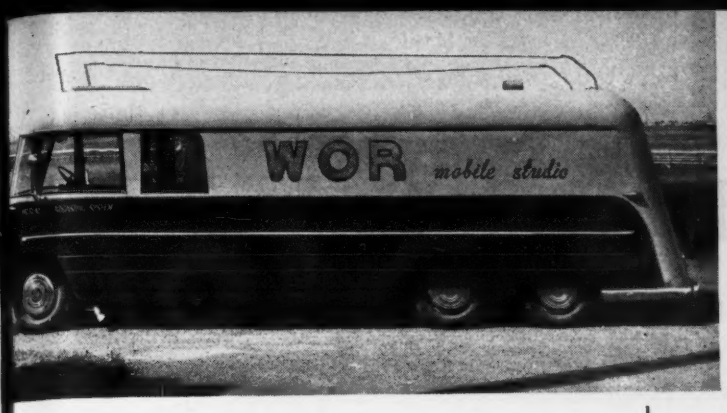
The vehicle is 27 ft. long and contains a soundproof 8 by 10 ft. studio which can accommodate as many as eight persons and has a full-sized microphone desk and lounge divan. A subscriber radiotelephone leased from the New York Telephone Co. is used to keep in touch with all points when conventional telephone service is not available.

Disc and Wire Recorders

Microphone outlets are available on both sides of the truck so that lines can be run for on-the-street broadcasts. A parallel arrangement of the microphone plugs enables a maximum number of outlets for convenience with six input channels.

Disc and wire recording equipment comprises part of the equipment to allow on-the-spot transcriptions in case of transmitter failure, erratic propagation, delayed broadcasts, etc. One of the wire recorders is spring wound, and is adapted from a British Broadcasting Co. model used during the war by paratroopers who made recordings behind enemy lines.

Field supervisor, George Reilly, reports that the new mobile studio fills a need for rushing complete studio broadcasting facilities to particular areas of news breaks where minutes are important. The truck was designed by Gordon Coleman Associates, industrial designers, and constructed by the Linn Coach Co.



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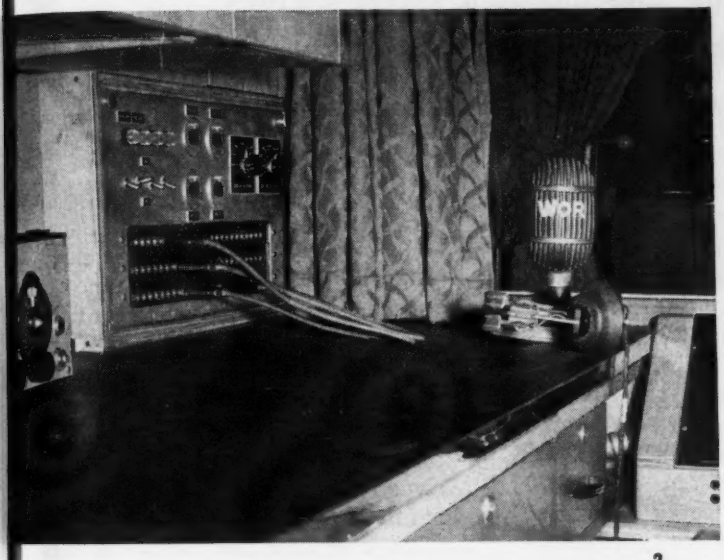

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1—Luxuriously equipped, WOR's mobile field pick-up studio is housed in a vehicle especially designed for the purpose. Note top antenna

2—View inside the vehicle looking toward studio compartment and showing part of the control panel and a patch panel for microphone feeds

3—Looking forward at the driver's seat, and, at the right, forward position from which an announcer can work, in front of the studio

4—General view of the miniature studio, with semi-circular lounge seat directly in front of glass partition between studio and transmitters

5—Looking forward at the operating control panel. From this position engineer has clear view of studio. Transmitters are at right and left

6—View of the studio compartment, which is roomier than it appears, with a glimpse through glass partition at engineer operating the controls

6

Design of Simple Sync Generator

By EDWARD M. NOLL, Temple University, Philadelphia

Details of a 60-frame 260-line non-interlaced system useful as a basic timing and shaping unit and for checking purposes

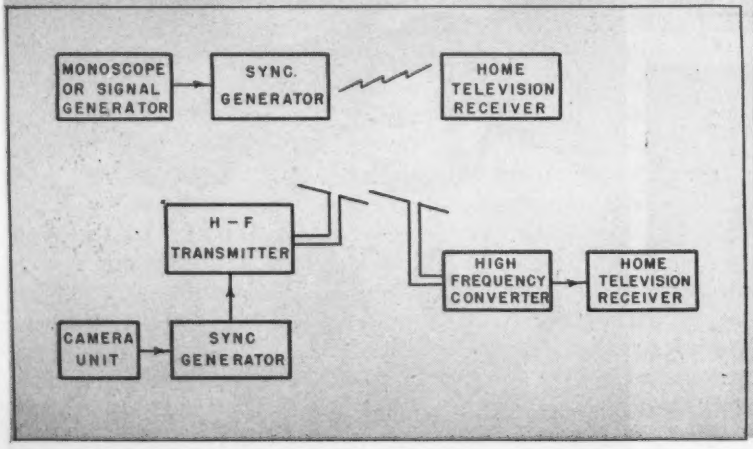
THIS simple sync generator in six tubes generates, shapes and forms a composite television synchronizing signal. The vertical repetition rate can be adjusted to 60 per second and the horizontal repetition rate can be adjusted to 15,750 pulses per second. Therefore the output of the synchronizing generator can be used to check the sync and sweep system of a convential television receiver, or can be used as a basic timing unit for an industrial or amateur television system. The durations of the vertical and horizontal sync and blanking pulses can be made comparable to the durations of the standard FCC synchronizing waveforms.

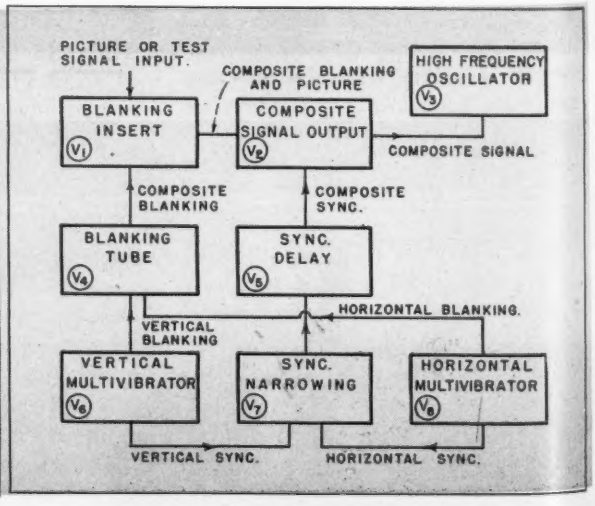
• In this sync generator, slotted vertical pulses are not used; likewise, equalizing pulses are absent. Consequently, there is no interlace scanning pattern. Instead, the television system consists of 60 frames and approximately 260 lines. It is evident therefore, that the vertical resolution will not be as good as that obtained from a standard interlaced 525-line signal.

However, this is not disadvantageous in testing receivers or in an amateur television system because the vertical resolution is almost entirely the function of the number of lines. The performance of the television receiver has little effect on the vertical resolution. The horizontal resolution of the television system, however, is dependent on the bandwidth and performance of the television rf, IF and video section. With a 60-frame, 260-line system the horizontal resolution of the television system must be the same as it is for the reception of the standard interlaced signal. Therefore, the output of the sync generator when mixed with a monoscope signal, or an actual television signal, will give an indication of the horizontal resolution and therefore the bandwidth and efficiency of the television receiver. The performance of the sync and sweep system of the television receiver can also be judged with this sync generator by observing the rigidity of the pattern or by placing a test scope at strategic points in the sync and sweep system and observing the resultant waveforms.

Another decided advantage of the 60-frame, 260-line synchronizing signal so far as amateur operation is concerned is that the conventional home television receiver can also be used with the amateur television station. Inasmuch as the generated signal is of the proper character to be usable by the home television receiver, it means that a simple converter can be built for the television receiver and placed at its front end to receive the television signal on some higher frequency amateur television channel. This condition is necessary to make the television receiver adapted to amateur operation.

Fig. 1—Interconnection block diagram of non-standard TV system
Fig. 2 (right) Block diagram of sync generator and mixing stages





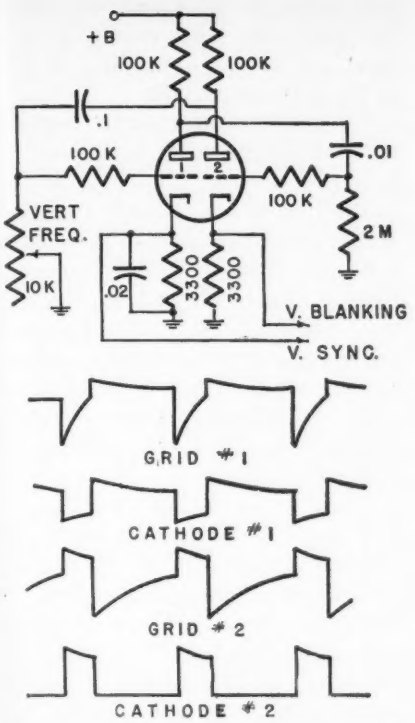


Fig. 3—Circuit of vertical timing multivibrator with waveforms

This sync generator is also adaptable to a monoscope unit. The monoscope unit itself is generally a 60-frame non-interlaced system. The monoscope signal is generally applied directly to the input of the video amplifier of the receiver and the sweep oscillators of the monoscope and receiver are synchronized directly. With the addition of the sync generator however, the monoscope signal can be applied to it and the rf and IF system of the television receiver can also be checked. The monoscope sweep oscillators will be synchronized by pulses from the sync generator.

In summation, the sync generator generates a non-standard synchronizing signal which can be used accurately to check the performance of a television receiver and as a basic timing and shaping unit of a non-standard television system. The design and size of the generator is very much reduced and simplified with the absence of an interlaced system and its necessary equalizing and slotted vertical pulses.

The block diagram showing the interconnections necessary to use the sync generator to check receiver performance and as a basic timing unit for a television system are shown in Fig. 1. As shown in the first drawing, to check receiver performance the composite signal output of the sync generator is used to modulate a small oscillator. Thus the sync generator in this application is comparable to a 400-cycle modulated signal generator used in receiver checks of home broadcast receivers. In this case, however, the high frequency signal generator is modulated by a composite television signal. In this application an actual picture signal can be derived from a monoscope unit and used to modulate the high frequency oscillator.

An alternative method, when no monoscope unit is available, is to use the conventional beat-frequency audio oscillator and a middle range signal generator. Thus, various frequencies from the very low audio frequencies to approximately 5 mc can be applied to the video input of the sync generator. These sine-wave signals will produce a series of bars on the television screen—horizontal bars for the lower frequency applied signals and vertical bars for the higher frequency applied signals. Resolution and linearity of the television sweep system can be judged accurately by observing their spacing and clarity of the separation between vertical bars.

Non-Standard System

In a non-standard television system the composite signal output of the sync generator is used to modulate a high frequency transmitter. The sync generator also synchronizes the sweep system of the camera tubes. A new economical camera tube, soon available in quantity, uses a sweep system which can be conveniently synchronized with this sync generator.

A block diagram of the sync generator, designed and constructed in connection with laboratory experiments in the television course at Temple University, is shown in Fig. 2. The basic timing oscillators are two multivibrators, one on 15,750 cycles and another on 60 cycles. The vertical oscillator is a conventional unbalanced multivibrator and output is taken off both cathode circuits—one output is the blanking and the second output is used for the synchronizing process.

The vertical multivibrator is a cathode feedback multivibrator

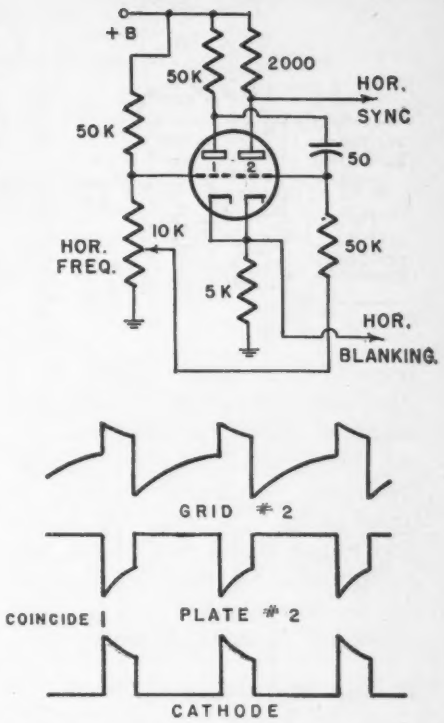


Fig. 4—Circuit of horizontal timing multivibrator with waveforms

with the blanking taken off the cathode circuit and a pulse, used to generate the horizontal sync pulse, off the plate circuit of the second section. Horizontal and vertical blanking pulses are combined in the blanking and limiting stage tube V-4. Blanking and picture signals are combined in the blanking insert stage, tube V-1.

Vertical and horizontal sync signal is fed from the multivibrators to a sync narrowing circuit which reduces the vertical and horizontal sync pulses to the proper durations. The output of the sync narrowing circuit is applied to a sync delay circuit. In this circuit, the leading edge of the horizontal sync pulse is delayed with respect to the leading edge of the horizontal blanking pulse. Thus a front porch is formed on the blanking pedestal similar to the front porch of the standard FCC composite signal. This means the deflection circuits are less susceptible to noise synchronization.

The composite sync signal is combined with the composite blanking and picture signal in the cathode circuit of the composite signal output tube, V-2. The control in the output circuit of the sync delay tube permits precise control of the sync amplitude so the blanking pedestal level can be set at approximately 75%. In this

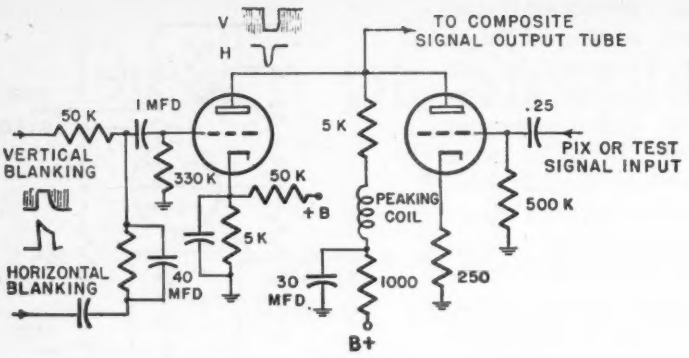


Fig. 5—Arrangement of blanking and blanking insert tubes

respect it is again similar to a standard composite signal. The output of the composite signal output stage modulates a simple high frequency oscillator which is tuned to the high frequency television range. Using this simple low output oscillator the sync generator can be conveniently used to check television receiver performance.

Timing Multivibrators

The two timing multivibrators, vertical and horizontal, are shown in Figs. 3 and 4. The vertical multivibrator is a conventional circuit with a long time constant in the second section and a short time constant in the grid circuit of the first section. Inasmuch as the second section grid time constant is long and the first section short, a very short duration pulse will appear in the cathode section of the second section. (Observe waveforms). Time constants have been chosen to keep the duration of this cathode pulse at approximately 5 to 10% of the vertical period. Therefore, it corresponds to the vertical blanking period of the standard FCC transmitted signal.

Observation of the multivibrator waveforms also shows that across the first section cathode a long duration pulse is obtained and what is more, the trailing edge of this longer duration pulse coincides with the leading edge of the short duration pulse. It is convenient, therefore, after differentiation to use the trailing edge of this long duration pulse as the actual transmitted sync pulse. The frequency of the multivibrator can be precisely set on 60 cycles with the potentiometer in the grid circuit of the first section which, over a limited range, controls the time constant of this grid circuit.

The horizontal multivibrator, Fig. 4, is a cathode feedback type which operates efficiently and with stability at the higher horizontal frequency. Across the cathode circuit of this multivibrator we also obtain a short duration pulse which eventually will produce a horizontal blanking pulse which is 15% to 20% of the horizontal period. This again corresponds to the normal horizontal trace and retrace periods of the composite interlace signal transmitted by all television stations.

The horizontal sync signal is derived from the plate circuit of the second section of the multivibrator and again the differentiated trailing edge becomes the horizontal sync pulse and, of course, it must coincide with the leading edge of the horizontal blanking pulse developed in the cathode circuit of the multivibrator.

The blanking tube combines first in its grid circuit the vertical and horizontal blanking pulses. In addition to combining these pulses, the blanking tube also acts as a limiter and squares off the pulses to make them rectangular. Limiting action is obtained, of course, by operating the blanking tube near cut-off, by applying B plus to its cathode circuit.

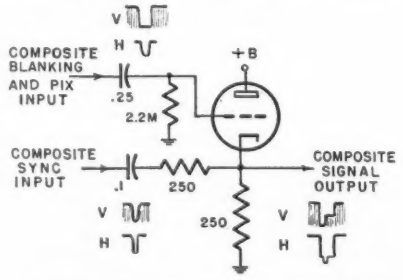


Fig. 6—Composite signal output tube

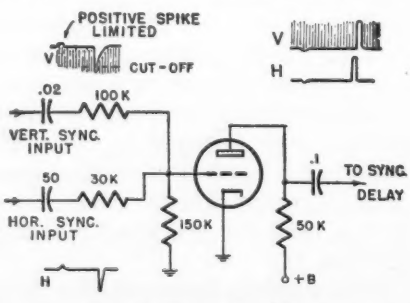


Fig. 7—Narrowing circuit

To prevent interaction between multivibrators it is necessary to put the proper isolating circuits in the line which feeds the vertical and horizontal pulses to the blanking stage. Thus a 50,000-ohm series resistor effectively isolates the vertical multivibrator from horizontal signals and a 60-mmf capacitor in shunt with a 5000-ohm resistor effectively isolates vertical components from the horizontal multivibrator.

These de-coupling circuits also function as voltage dividers and equalize the horizontal and vertical blanking signals as they appear in the plate circuit of the blanking tube. Another function of these two tubes is to combine the composite blanking signal with the picture or test signal being applied to the grid of the blanking insert tube, Fig. 5. The two signals are respectively combined across the common plate resistor of both stages. Thus in this plate circuit composite, blanking and picture are combined and the amplitude of the picture signal during the blanking period, of course, is very far negative because the blanking pulses appear as sharp negative pulses in the plate circuit of the blanking tube, V4. This composite picture and blanking signal is applied to the grid of the composite signal output tube, V2, Fig. 6.

Composite Signal Output Stage

In the composite signal output stage the final composite signal is formed when the composite sync pulses, horizontal and vertical, are combined with the composite blanking and picture signal in the cathode circuit of the composite signal output tube. In addition to serving as the composite signal output stage, this tube also operates as a grid circuit limiter or clipper. The composite blanking pulses applied to its grid are of sufficient amplitude to drive the tube beyond cut-off, consequently, any stray picture signal which might remain on the blanking pulse is removed and a flat pedestal is formed upon which the sync pulse is mounted. Actually, this

pedestal represents the composite signal output tube not conducting and the sync pulse is negative and adds to the negative voltage applied to subsequent stages, in this case, to the oscillator tube.

The sync narrowing circuit (Fig. 7) produces vertical and horizontal sync pulses of the proper duration. It consists of first, a differentiating circuit which only allows the leading and trailing edges of the pulses to appear on the grid of the narrowing tube. The actual width of the edges it permits on the grid of the narrowing tube, is dependent on the time constant of the differentiating circuit. A 50-mmf capacitor differentiates the horizontal sync pulse while a .02-mf. capacitor differentiates the vertical pulses.

Actually, the differentiating circuit produces a positive spike for the leading edge and a negative spike for the trailing edges of the differentiated square wave. However, the positive-going leading edge is limited by the sync narrowing tube and only the negative-going spike or the trailing edge produces a useful signal on the grid of the narrowing tube. Thus in the plate circuit of the narrowing tube, positive-going pulses of the proper width for horizontal sync and vertical sync are produced.

Sync Delay Circuits

These positive-going sync pulses coincide with the trailing edges of the applied pulses. However, the circuit is properly arranged so the trailing edge of the applied pulse coincides with the leading edge of the actual blanking pulses. Thus the leading edge of the sync pulse as it appears in the plate circuit of the narrowing tube coincides with the leading edge of the blanking pulse as it appears in the plate circuit of the blanking tube. The duration of the vertical sync pulse is approximately 300 to 400 microseconds while the duration of the horizontal sync pulse is approximately 5 microseconds.

To make the television system less susceptible to noise and erratic firing of the horizontal oscillator in the receiver on noise impulses, a delay circuit is necessary to delay the leading edge of the horizontal sync pulse with respect to the

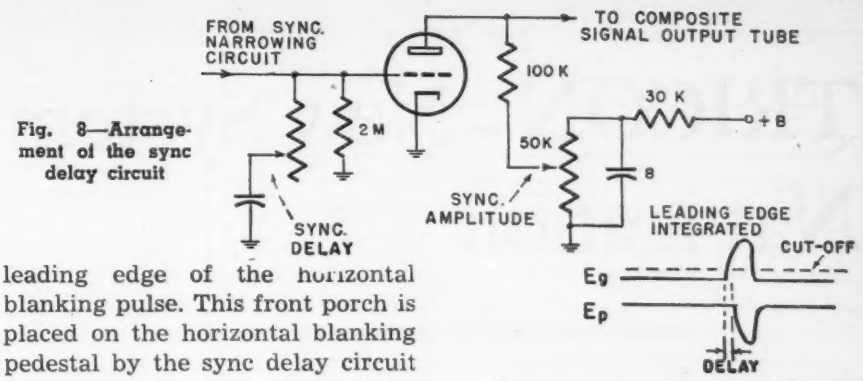


Fig. 8—Arrangement of the sync delay circuit

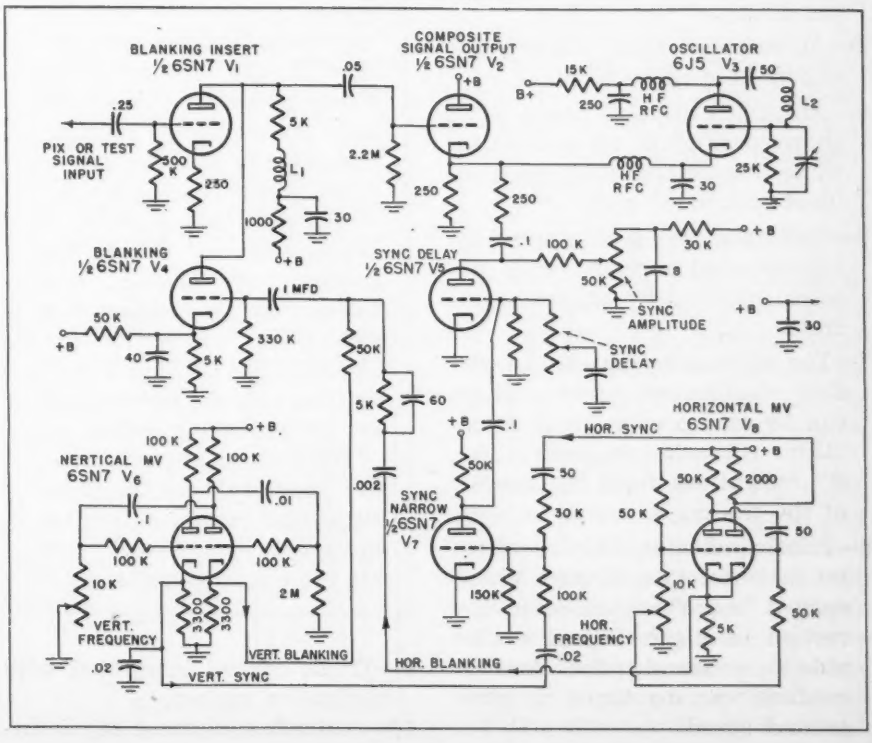
leading edge of the horizontal blanking pulse. This front porch is placed on the horizontal blanking pedestal by the sync delay circuit in the grid circuit of the delay tube.

Actually, this delay circuit consists of a simple integrator whose characteristics can be varied with the sync delay control. The sync delay tube, of course, is signal biased and a portion of the integrated wave appears below cut-off as shown in Fig. 8. That portion of the sync pulse below cut-off does not appear on the plate circuit of the sync delay tube. Thus the actual leading edge of the pulse which appears in the plate circuit of the sync delay tube is slightly after the leading edge of the sync pulse applied to the grid of the sync delay tube. Consequently, the leading edge of the horizontal sync is delayed a few microseconds with respect to the leading edge of the horizontal blanking signal as can be seen by observing the signal appearing across the cathode of the composite signal output tube.

A potentiometer in the plate circuit of the sync delay tube also controls the amplitude of the sync pulse. The sync pulse itself is reasonably flat on the top because the amplitude of the negative spike on the grid of the sync narrowing tube and the positive sweep on the grid of the sync delay tube is sufficient to clip possible curvature.

When the signal is picked up on a conventional receiver and the frequency controls properly adjusted, the scanning raster will be rigidly locked in. If a signal generator is applied to the picture input of the sync generator, actual bars, horizontal or vertical depending on the frequency of the signal generator, will appear rigid on the scanning raster of the receiver. The various wave forms as observed on a test oscilloscope applied to the various sync circuits of the receiver appear essentially as formed in the sync generator.

Fig. 9—Schematic diagram of the entire unit for generating sync pulses for a non-standard television system



TRICON - New System for Airplane Navigation

By ALBERT FRANCIS

Using pulse transmitters, triple coincidence receivers and electronic counters, Alvarez system promises revolutionary advance in navigation and traffic control for safety operation of commercial airlines

• The name "Tricon" for this new system is taken from Triple Coincidence Navigation because the reception of three pulses coincidentally is the basis of the system. The advantages claimed are—

1—High accuracy where needed, ±500 ft. transverse to the airtrack.

2—Narrow bandwidth, 2 mc for one 60-mile section; 4 mc total for all the land area of the world. This width includes both navigation and traffic control.

3—High traffic handling capacity. Two thousand aircraft can be handled with safety per 60-mile section, or 200 aircraft per minute past a point (at 300 miles per hour).

4—Automatic *moving* block indication from plane to plane.

5—Automatic dispatch board. This shows position of all aircraft in three dimensions, with positive identification of each.

6—Command link from ground to any selected aircraft, with no signal received by adjacent aircraft.

7—The airtracks used can be either straight or curved. They can be set up with great flexibility. Aircraft can secure "L-R" indications from the center of the tracks.

8—Pilot's indicator. This requires no interpretation, always gives correct "sense" regardless of direction of flight. Signal available for automatic pilot. Mileage readings can be timed to give ground speed.

SIX months ago, after a study of existing and proposed air navigation systems, a professor of physics at the University of California, Dr. Luis W. Alvarez, concentrated into the short period of five days the evolution of a new and improved system, which with practically no changes, appears flexible enough to take care of the present and future needs of the airlanes. After an exhaustive analysis of the technical, engineering and production features, the General Electric Co. declared the system feasible and economically sound. It was this company that sponsored the presentation of the system to the Radio Technical Commission for Aeronautics (RTCA), composed of military and civilian groups, during a meeting at the Navy Building in Washington, D. C. in September. Dr. Alvarez, well-known as the inventor of GCA, for which he was awarded the Colliers Trophy in 1946, was the main speaker. He did an excellent job of blackboard presentation—the fluent and concise exposition that results only when the speaker has "lived" with his subject for months.

9—Traffic control integrated with navigation system.

10—Aircraft equipment can be installed and used, step by step, because system is evolutionary. First step can be installation of equipment to give navigational information only.

Operational Information

To aid in describing this new system, operational philosophy in accord with the February 1947 proposal of the Air Transport Association will be used. Visualize aerial highways composed of tracks spaced laterally and vertically. Assume the track separation is 2 miles. The line-of-sight radio transmission of the vhf dictates highway segments of about 60 miles in length. Such a 60-mile segment, containing 10 tracks, with 2-mile spacing between tracks and 4-mile spacing across the center, is shown in Fig. 1. The upper five tracks, A to E, are for planes flying to the left; the lower five are for traffic in the reverse direction.

THE PILOT'S INDICATOR. The system works on a moving block principle wherein the blocks are in effect tied to the plane; a system vastly superior to the stationary block system used by the railroads. The pilot sets his block system knob (Fig. 2) to indicate planes within 6 miles of him. Or if he chooses he can look ahead distances up to 15 miles. This information is secured plane-to-plane, not via the ground.

Any plane on the same airlane, at the same altitude, within the selected 6-mile distance will cause the BLOCK signal to light and a warning note will be heard in the

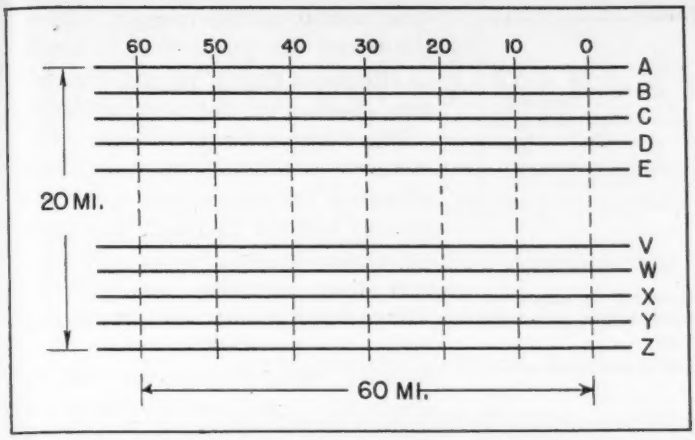


Fig. 1—Plan view of airlane layout showing length, disposition and physical arrangement of individual lanes

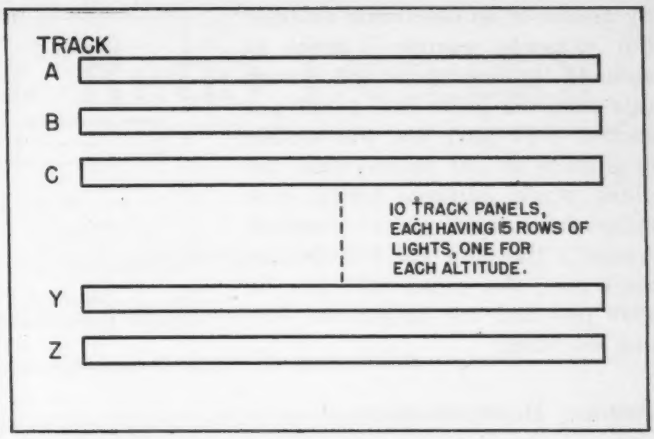


Fig. 3—Layout of controller's dispatch board which would indicate position and altitude of all airplanes at once

pilot's 'phones. If the pilot is about to change altitude or tracks, he can set the block knob at the appropriate setting and satisfy himself that there is no plane with which he might collide in the direction he is about to go. Of course he normally would not so maneuver unless told to do so by the ground controller.

The lights to the right of the L-F indicator are to receive instructions from the ground. When the lamp lights there is a warning tone in the pilot's headset to call his attention to it. Different lights may indicate brief orders regarding changes in altitude or lane. Detailed instructions can be transmitted by voice. Upon receiving such signals the plane sends back a confirmation, called an automatic "Roger".

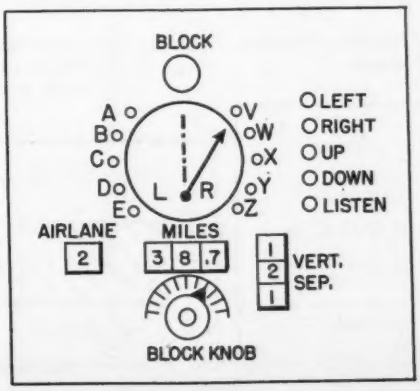
Operation on the Ground

A large dispatch board shows, by means of lights, the location of all the planes on a particular section of the airway, their altitude, track number, and odometer reading. A coded series of lights along the dispatch board "track" indicates the identity of the plane. The number of lights on the board would be 120 per track, times 10 tracks, multiplied by 15 for 15 altitude indicators, giving a total of 18,000. The layout is shown in Fig. 3, and in Fig. 4 we see the detail of just one track, say, Track W. On this track two planes are shown, one at 7000 feet, one mile from the end of the block; the other at 8000 feet, six miles from the end of the block.

Control men on the ground have all the information they need to control traffic by looking at the dispatch board. To signal instructions to a plane, the controller pushes buttons corresponding to the plane's track number (or letter) altitude distance along the airway together with the code number of the instructions it is desired to transmit. The corresponding signal light is lighted in front of the pilot in the desired plane *and in no other plane.*

We come now to the question of how the operations just described are carried out by the use of radio, coupled with already-known electronic devices. It is understood by the reader that the Tricon system is in the proposal stage and that it was presented by its originator, Dr. Alvarez, in the form of a blackboard talk; therefore the following notes, instead of giving an explanation of every detail, merely undertake to outline, with broad strokes, the high points of how such a system might be made to function. It is expected that the originator in the near future will describe the technical operation in detail.

Fig. 2—Appearance of pilot's indicator board as devised for new Tricon system



THE ESTABLISHMENT OF A TRICON AIRLANE. On the ground three radio transmitters are assumed in operation on the same frequency, each pulse-modulated with pulses occuring at exactly the same time, that is, in phase. If these are located as in Fig. 5, the airlane resulting will lie as shown when it is mapped by moving a *triple coincidence receiver* along it. This special airborne radio receiver, responding only when three pulses are received coincidentally, is indicated in block form in Fig. 6. For simplicity it is diagrammed as having three separate antennas and tuners, the outputs of which feed into a triple coincident circuit which produces at its output a single pulse only when three incoming pulses are received simultaneously. Returning now to Fig. 5 we find that there is only one location on the airway where this receiver will respond and that is point Y, equi-distant from the three transmitters.

Master and Slaves

If we desire to receive a signal at, say, point Z, then it is necessary to shift the modulating phase of at least two of the stations to produce triple coincidence at this point, thus a new airline is established through point Z.

Actually Sta. A in Fig. 5 is operated as the *master* station and Stations B and C are operated as "slave" stations, as in LORAN practice. The method of measuring *distance* along a track involves sending from the ground stations accurately spaced pulses and counting these on board the plane

by means of an electronic counter. For example, assume it takes 10 seconds for one cycle and during this time the pulse rate is 100 per second (100 pps) and the section of airlane is 100 miles—then the plane would advance 1/10th of a mile for each pulse counted. Actually the time for 1 cycle can be 1 sec., the pulse rate can be 3000 pps and the lengths of section 60 miles.

Position Determination

Upon entering a new section of airlane a pilot tunes his receiver to the proper frequency, and at the start of the timing cycle his counter begins to count pulses until the triple response is received, whereupon the plane automatically transmits to the ground station a broad pulse which, due to its time of arrival in respect to the cycle timing will indicate, by means of lights on the control board, the plane's distance along the airway. Following this position report the plane transmits in coded impulses its name or identification, which also will show on the master control board.

The *altitude* of the plane, as indicated on its radio altimeter, is transmitted to the ground by a code which involves the radio frequency selected for trasmission of the plane's position signal.

The *airlane* along which the plane is flying is known at the ground control station because the plane's position signal will be received during the time the pulses are being transmitted from the ground for that certain airlane. Signals for each airlane are transmitted in a definite sequence, for instance, lanes V, W, X, Y, Z. Thus we see that the position of the plane is known at the control board because the airlane it is traveling is indicated, as is it's distance along it, and it's altitude is received as frequency-coded data.

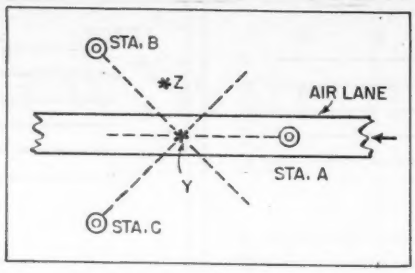


Fig. 5—Schematic showing locations of ground transmitters with relation to the airlane

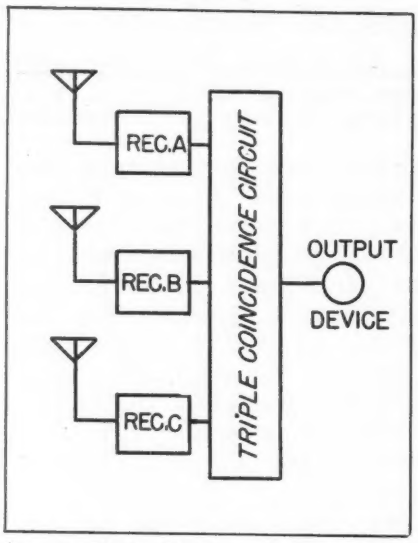


Fig. 6—Block diagram of Tricon triple coincidence receiver

TYPES OF PULSES EMPLOYED. It was stated in the meeting that the sharper the pulses transmitted, the greater the accuracy of the system. However, this can be pushed so far that it would be difficult for the pilot to find his position. Therefore, Sta. A and B in Fig. 5 are modulated by a fairly wide pulse followed by a sharp pulse, whereas Sta. C emits sharp pulses only. The "Left-Right" indicator responds to a double coincidence of pulses and is so arranged that if the sharp pulses *lag*, a "Left" indication results in the cockpit, and if they *lead* the pulse that is taken as standard, then a "Right" indication appears on the L-R indicator.

The "Annunciator" System. Dr. Alvarez explained that he had provided for commands from the ground control to reach the pilot by means of an annunciator system that operates as follows: After the plane automatically transmits its position pulse and identify, then its receiver has an electronic "gate" which opens to receive any messages that may be sent from the ground. Such brief messages would illuminate corresponding lamps on the plane's navigation system panel; involved messages would be handled by voice in the usual manner. The narrow band of radio frequencies used for the annunciator system differs somewhat from the band used for navigation. This logically brings us to the subject of radio frequencies proposed for Tricon.

Radio Frequency Demands

The Tricon system requires only 4 mc bandwidth; this includes the frequencies for annunciator service. From Fig. 7 it will be seen how the transmitters for a national airways would be laid out. The stations located on the section dividing lines can radiate on the same rf for both sections provided their modulation was different for the two sections. Radio frequencies in the 200 mc or the 1000 mc region were suggested. Line of sight transmission over a range of 60 miles is all that is required.

The assembled group of listeners were told that the ground control station would have control boards containing thousands of lamps,

(*Continued on page* 98)

Fig. 4—Detail of portion of Tricon dispatch board showing location of lights which indicate positions of all planes

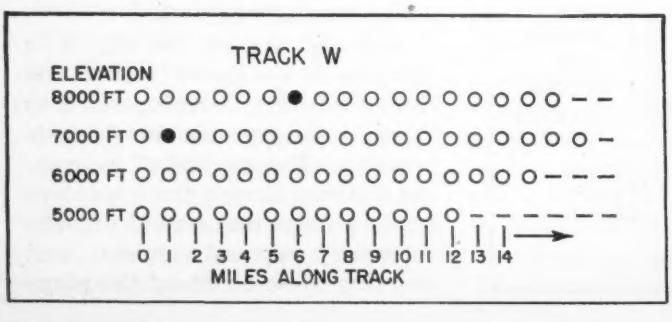
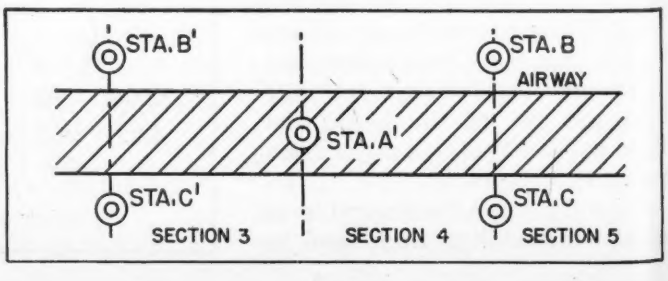


Fig. 7—The same transmitter can be used for adjacent airlane sections in the Tricon system provided different modulators are used for each section. Normally one transmitter would control two "slaves"



Improved Type of Ratio Detector

By ALBERT E. HAYES, JR.,
Bendix Radio Division, Baltimore

Originally developed as a mathematical computing circuit, the arrangement provides high transconductance for FM detection

• In an endeavor to simplyfy the design of FM receivers, and to eliminate the customary limiter stage or stages and yet maintain satisfactory AM rejection, a number of ingenious circuits recently have been evolved. Not the least interesting of these is the so-called "ratio detector", which delivers an output signal which is reasonably distortion-free and yet provides relatively good AM rejection.

Many workers, however, have found that the conventional ratio

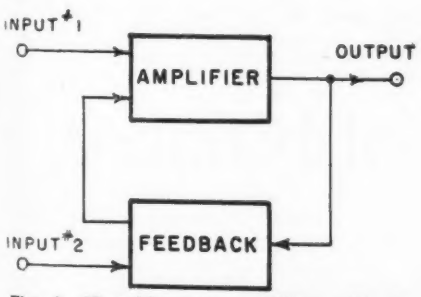


Fig. 1—Variable gain amplifier with degenerative feedback

detector, when adjusted for maximum AM rejection, is a comparatively insensitive device, yielding an output which is sometimes less than one-tenth the amplitude of the input signal, assuming a standard deviation of ±75 kc. This paper describes a circuit which was originally designed as a mathematical computing circuit, but which lends itself readily to use as a "ratio detector" with relatively high transconductance.

Fig. 1 illustrates an amplifier together with a type of feedback circuit, (in this case is a variable gain amplifier) which is so phased as to provide degenerative feedback around the main amplifier. The gain of the feedback amplifier is controlled by the amplitude of any voltage applied to the control terminal designated "input 2."

It is well known that in degenerative feedback systems having very high values of feedback the net gain across the system is substantially equal to $1/\beta$ where β is the "feedback factor," or the proportion of the output signal voltage which is applied degeneratively to the input circuit. This may be seen from the following analytical expression for voltage amplification where A is the amplification in the absence of feedback and A_f is the amplification taking feed back into account:

$$A_f = \frac{A}{1 - A\beta} \quad \text{.....(1)}$$

$$= -\frac{1}{\beta}\,\frac{1}{1 - \frac{1}{A\beta}} \quad \text{.....(2)}$$

It can be seen, from equations (1) and (2) that the gain with feedback, A_f, is substantially equal to $1/\beta$ when the feedback voltage $A\beta$ is large.

In the Fig. 1 arrangement the value of β, and consequently the

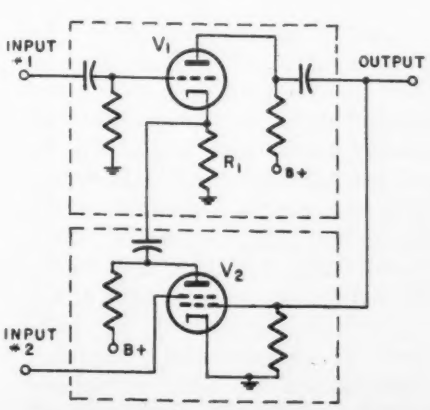


Fig. 2—Schematic arrangement of the amplifier

value of $A\beta$ may be made a linear function of the amplitude of the signal applied to the terminal "input 2", and equation (2) may be rewritten:

$$A_f = \frac{1}{kE_2} \quad \text{.....(3)}$$

where E_2 is the amplitude of the signal appled to "input 2" and k is a constant of proportionality introduced by the characteristics of the circuits employed. Designating the signal applied to "input 1" as E_1, and substituting E_{out}/E_1 for its

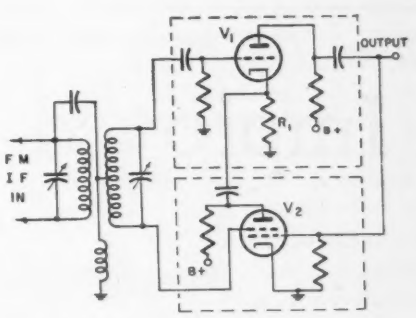


Fig. 3—Practical example of the arrangement of Fig. 1

definitive equal A_f, we get

$$\frac{E_{out}}{E_1} = \frac{1}{kE_2} \quad \text{.....(4)}$$

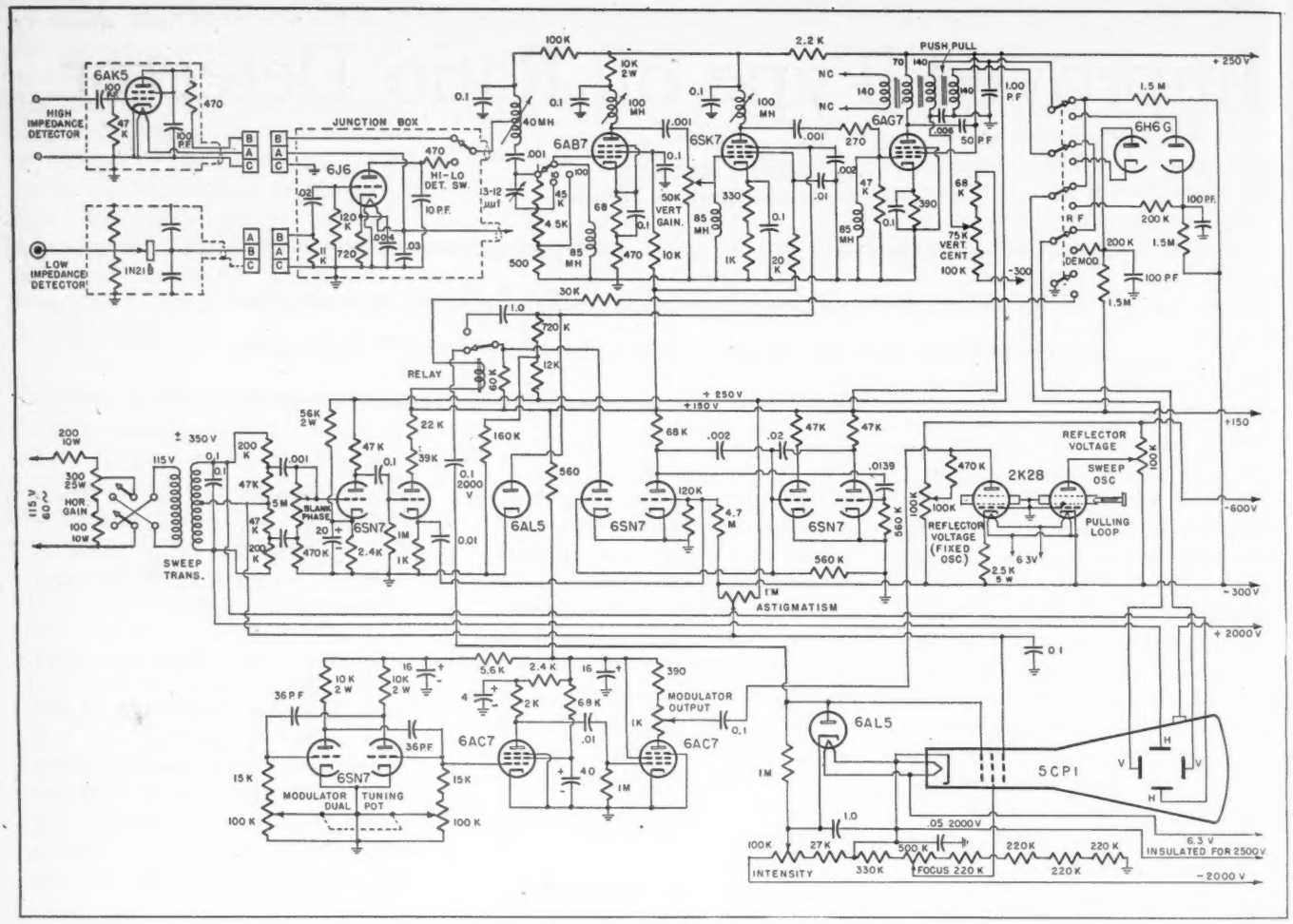
or

$$E_{out} = k\,\frac{E_1}{E_2} \quad \text{.....(5)}$$

Thus it may be seen that "E_{out}", the amplitude of the signal appearing at the output terminal, will, in the circuit of Fig. 1, be proportional to the ratio of E_1 to E_2, and that a true "ratio detector" results.

Fig. 2 illustrates a practical example of the arrangement of Fig. 1 in which a pair of vacuum tubes V_1 and V_2 replace the blocks of Fig. 1, and in which the feed-

(*Continued on page* 94)



Schematic wiring diagram for sweep circuit and vertical amplifier for wide band wobbulator

Improved Wide-Band Wobbulator

By CALDWELL P. SMITH*

Frequency modulated alignment oscillator and indicator giving excursions up to 160 mc over a range from 1 to 350 mc

• During the latter part of the war the Radiation Laboratory at M.I.T. developed a wide-band wobbulator to meet the need for making rapid measurements of frequency response over a wide frequency band; i.e., up to as much as 160 mc bandwidth. This article describes a similar instrument built at Cambridge Field Station incorporating several improvements and refinements to increase the versatility of this device.

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The term "wobbulator" describes a type of alignment oscillator in which the carrier is swept periodically over the desired frequency band, with provisions for using a synchronized cathode ray tube as response indicator. In the instrument being described the indicator tube, amplifier, and sweep circuits are an integral part of the wobbulator. Sensitivity is sufficient to present the frequency characteristic of coils, capacitors, and resonant circuits without additional amplification.

To obtain the wide frequency range desired, two reflex klystrons operating in the 10 cm range are heterodyned, one being swept in frequency by mechanical means and the other operating at a fixed frequency. The desired heterodyne output is generated by combining the two signals in a crystal mixer.

In addition to being swept in frequency, the heterodyne output is modulated at 125 kc by amplitude-modulating the fixed-frequency klystron with a square-wave voltage. This has the effect

of switching the output off and on in 4-microsecond pulses as the signal is swept through the frequency range. The output signal of the mixer therefore consists of the nominal heterodyne output plus sidebands due to the square wave modulation, in addition to the true 125 kc square wave. Since the latter signal is undesirable, a 1 mc high-pass filter is inserted between the crystal mixer and the mixer output terminal to prevent the 125 kc square wave from appearing directly in the output signal. This filter, however, does not remove the sidebands of the swept signal.

Frequency-response measurements are made by connecting the mixer output signal directly to the circuit under test, and detecting the output voltage from the test circuit with a probe-mounted detector. The output signal from the detector includes a 125 kc voltage the amplitude characteristic of which is a square-law function of the band-pass characteristics of the circuit being tested. It is this 125 kc signal that is amplified and applied to the cathode ray tube.

Use of the 125 kc "keying" has some notable advantages: usual wobbulator design requires dc amplification of the detected signal, which imposes limitations as to sensitivity, low-frequency phase shift, and permissible amount of stray 60-cycle pick-up. Here only the 125-kc components are amplified and sensitivity is limited only by noise signal present in the detector and amplifier. Effects of low-frequency phase shift and hum are inconsequential. It is also unnecessary to make the direct connection to the detector required in conventional wobbulators, since the 125 kc signal will pass through most video amplifiers.

In making stage-by-stage alignment, individual IF stages may be used as detectors by taking off the 125 kc signal from the cathodes, providing self-biasing resistors are used and the reactance of the cathode by-pass capacitors is sufficiently large at 125 kcs. The tuned circuits thus measured do not have their band-pass characteristics modified by the wobbulator connection.

The disadvantage of using the 125-kc modulation is that the minimum resolution is broadened in effect to about 750 kc bandwidth. However, this is not a serious limitation in making the wideband measurements for which this instrument was designed.

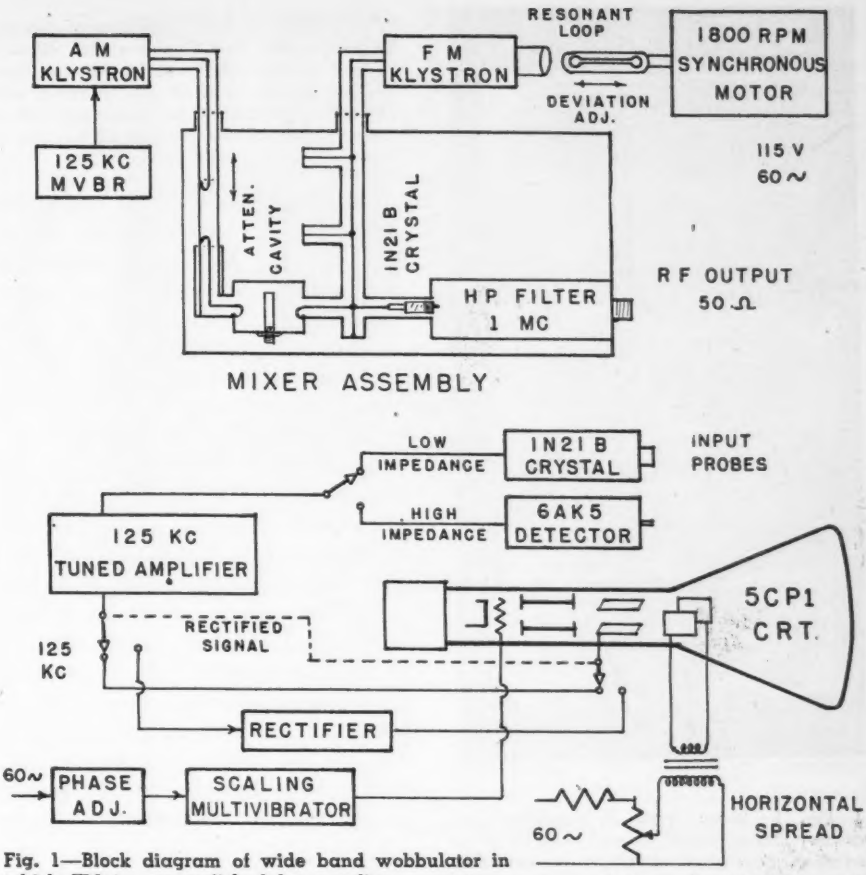


Fig. 1—Block diagram of wide band wobbulator in which FM is accomplished by coupling a rotating resonant loop to the klystron cavity

Two methods of presentation are available: (1) the output of the indicator-amplifier may be connected directly to the deflection plates of the cathode-ray tube and the 125-kc signal, amplitude-modulated by the band-pass characteristic of the circuit under test may be viewed directly on the screen; (2) the output may be switched to a rectifier and the rectified signal (i.e., envelope) viewed.

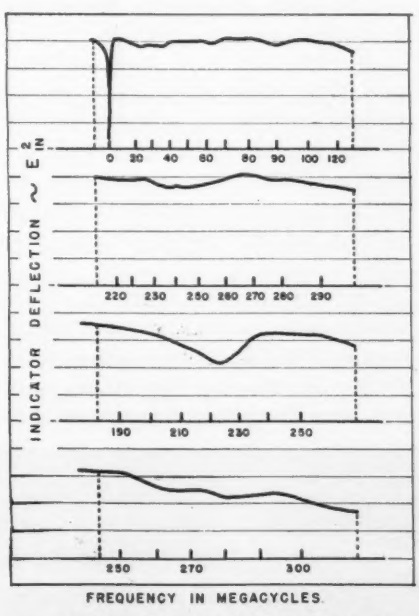
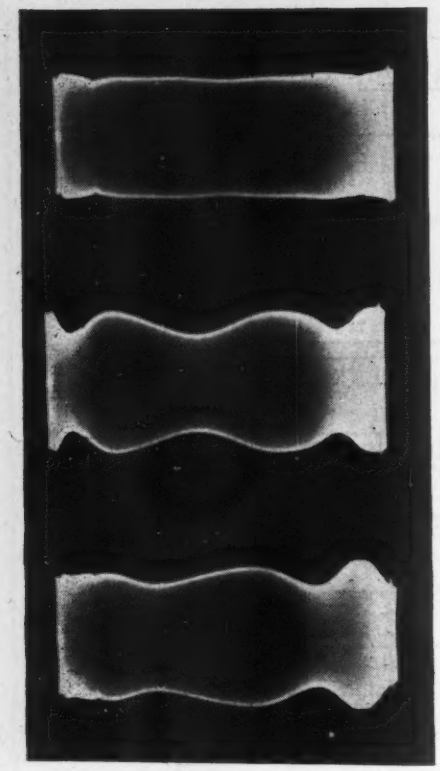


Fig. 2—Wide band wobbulator data showing uniformity of mixer output to function of frequency. Repeller voltage optimum for each range; crystal load connected direct

Various parts of the system are indicated in the block diagram shown in Fig. 1. Frequency-modulation is accomplished by coupling a rotating resonant loop to the 2K28 klystron cavity. Since the natural resonant frequency of the loop is tuned slightly lower than the klystron cavity, the oscillation frequency is "pulled" in accordance with the loop rotation. Proportions of the loop are such that the frequency deviation is very nearly a sinusoidal function of loop rotation, permitting use of sinusoidal sweep voltage on the indicator tube to obtain a nearly linear sweep.

The frequency deviation is determined by the loop insertion, which may be varied from the front panel by a rack-and-pinion drive on the motor mount. Since the loop coupling passes through two maxima for each complete ro-



← Fig. 3—Low impedance detector shunted with 20-ft. section of RG/21U "lossy" cable connected in 50-ohm (top), 72-ohm (center) and 50-ohm shunted with 15 mmfd. (bottom). Zero frequency slot at extreme left; marker slot at 22 mc, pip at 100 mc

tation, loop rotation at 1800 rpm permits use of 60-cycle sweep voltage. As the loop cannot be perfectly symmetrical, the indicator tube is intensified for only 90°.

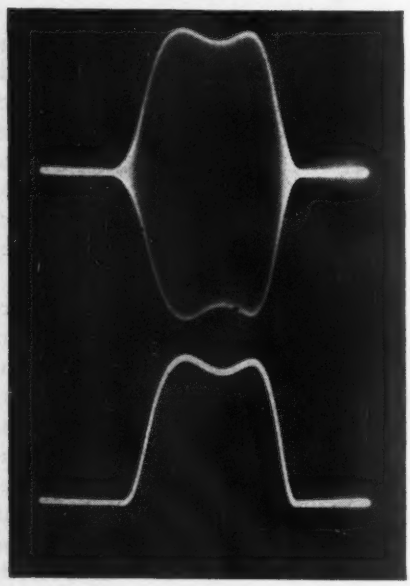
The mixer assembly is separately housed in a small cabinet, containing the mixer plumbing, 1N21B crystal mixer, and 50-ohm high-pass filter which prevents the square wave from feeding straight through to produce a response irrespective of heterodyne frequency. Stray capacitance and lead inductance in the filter have been minimized in order to obtain uniform output amplitude. A properly terminated 50-ohm cable must be used for connecting the mixer to the circuit under test. Output response vs. heterodyne frequency is plotted for the various frequency ranges in Fig. 2.

Harmonics in the mixer output are kept small by keeping the input signal from the fixed-frequency klystron small compared to the swept signal and by avoiding amplitude limiting when testing amplifying devices. An auxiliary step-attenuator having flat frefrequency characteristics is useful for further attenuating the input signal when testing high-gain IF strips.

The high-impedance probe uses a triode-connected 6AK5 as a grid-leak detector and has sufficient sensitivity that only a few micro-microfarads of capacitance are required to couple to the circuit under test. The low-impedance detector matches the 50-ohm mixer output, and utilizes a 1N21B crystal.

The overall performance of the wobbulator is easily checked by connecting the low-impedance detector directly to the mixer output, and observing the response on the indicator. Mixer crystal current due to both klystrons will be from 2.0 to 4.0 ma, depending on the attenuator setting. Any convenient signal generator may be loosely coupled to the detector to produce a calibration marker "pip" which will be useful in aligning the klystron frequencies and in adjusting the repeller volt-

↓ Fig. 5—10-mc wide IF amplifier frequency characteristic viewed with RF presentation (top) and envelope presentation (bottom)



↓ Fig. 4—Effect of bypass capacitor lead length—50-ohm detector shunted with .002 mfd. paper capacitor with (l to r) 2-in., 1-in. and ¼-in. leads, and 500 mmfd. ceramic capacitor with ½-in. leads. 105 mc sweep with marker pip at 100 mc

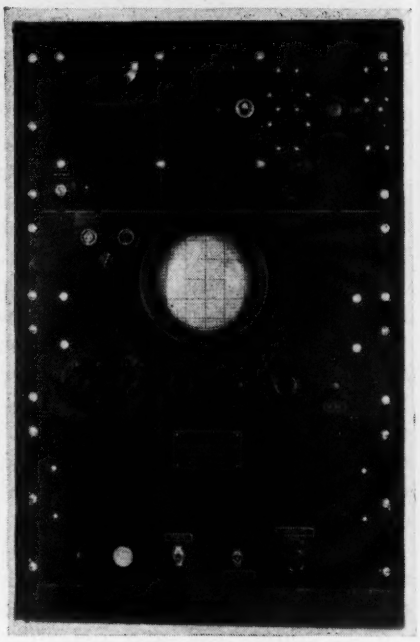


Fig. 6—Front view of wobbulator

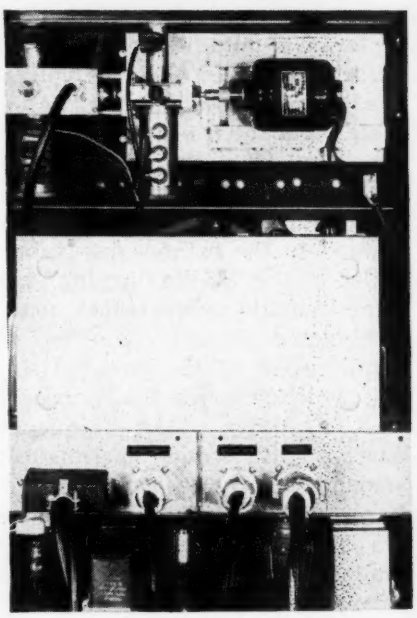
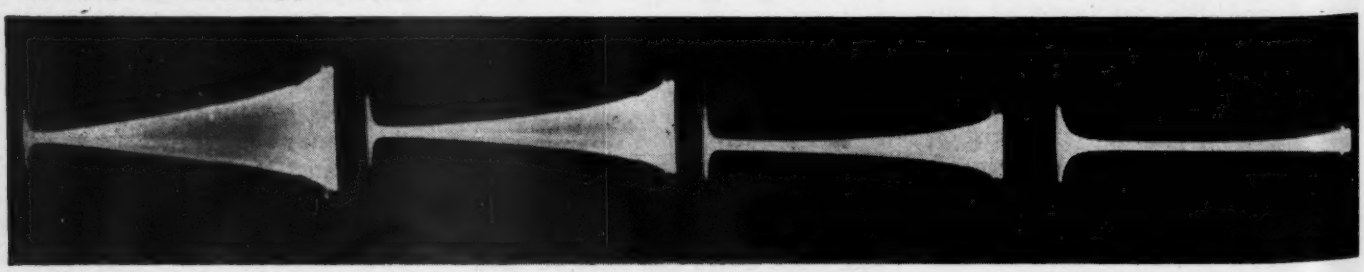


Fig. 7—Rear view of wobbulator



age on the amplitude-modulated klystron. Frequency "twinning", evidenced by two slightly separated marker pips from a single calibration signal, occurs when the square wave does not switch the klystron in and out of oscillation, but switches the repeller voltage between two points on the mode.

With random orientation of the rotating loop on the motor shaft, the pattern will be symmetrical about some point on the trace at maximum or minimum frequency swing; rotating the loop with respect to the motor shaft will allow positioning the frequency excursion to start at the beginning of the sweep.

In order to get the desired amount of frequency excursion without discontinuities in output, the cavity on the swept klystron is tuned close to the resonant frequency of the loop. The orientation of the loop resonance with respect to the cavity may be determined by measuring the amount of frequency deviation for a fixed value of loop insertion, and then changing the klystron to a new frequency; as the klystron frequency approaches the loop frequency the amount of deviation increases. Too close a frequency proximity will result in frequency "jump" and output discontinuities.

After adjustment of the frequency-modulated klystron for the desired amount of maximum deviation, the fixed - frequency klystron may be tuned to bring "zero" frequency to the right-hand side of the sweep. The mixer cavity must also be tuned during this adjustment. Tuning will require little readjustment once set for a given range; operation is controlled with the "Frequency Deviation" (which controls the amount of loop insertion) and "Center Frequency" (which tunes the frequency-modulated klystron cavity) adjustments.

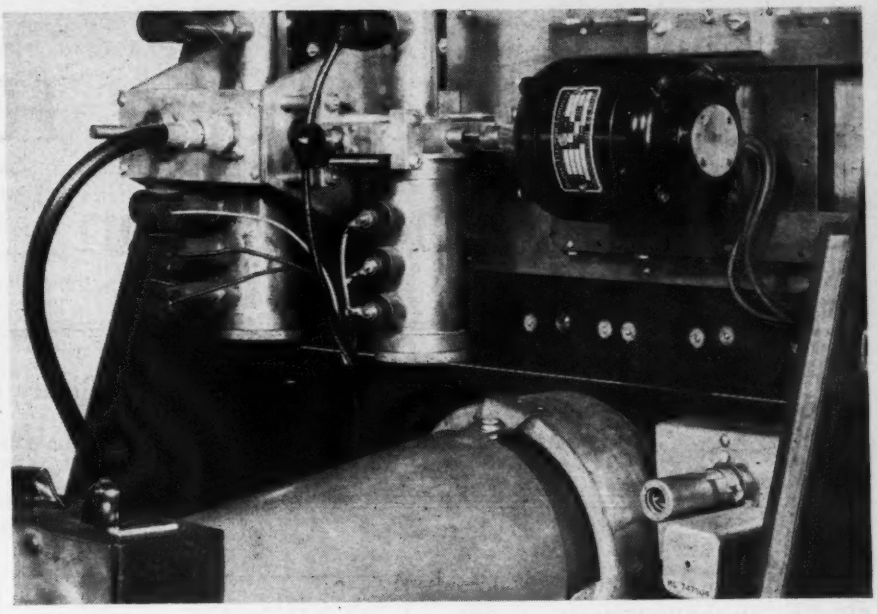


Fig. 8—Detail of klystron assembly

A few applications of the wide-band wobbulator will be mentioned; many others will doubtless suggest themselves. Effects of cable terminations may be ascertained by connecting the low-impedance detector to the mixer output through a Tee fitting, and connecting the cable to be measured in shunt. Some effects of cable terminations are indicated in Fig. 3. Since the pattern that will be obtained is a sensitive measure of the cable termination, one application is in tube selection: tubes can be selected to have a Gm within desired limits from a design-center value. A method is to place the tube in a cathode-follower circuit used to terminate a length of coaxial cable of suitable impedance, with parameters of the cathode-follower circuit adjusted for the cable to be matched when the conductance of the tube being measured has the design-center value. Tubes deviating from this value of conductance result in the cable not being correctly terminated and a varying frequency characteristic which can be ascertained quantitatively by visually observing the "depth of modulation" of the 125-kc pattern or metered with a percentage-modulation measuring device.

Parasitic circuit resonances over a wide frequency spectrum can be quickly determined using the wide-band wobbulator. Some effects of lead-length of effectiveness of by-pass capacitors are illustrated in Fig. 4. A typical IF response curve is shown in Fig. 5, showing the types of presentation. The complete unit is shown in Figs. 6-10.

Fig. 9—Mixer assembly

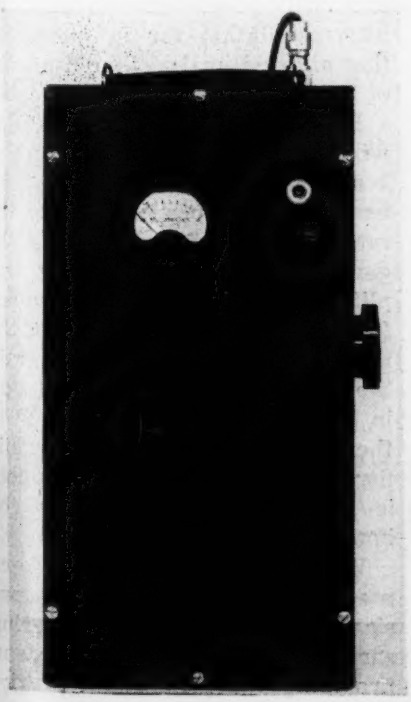
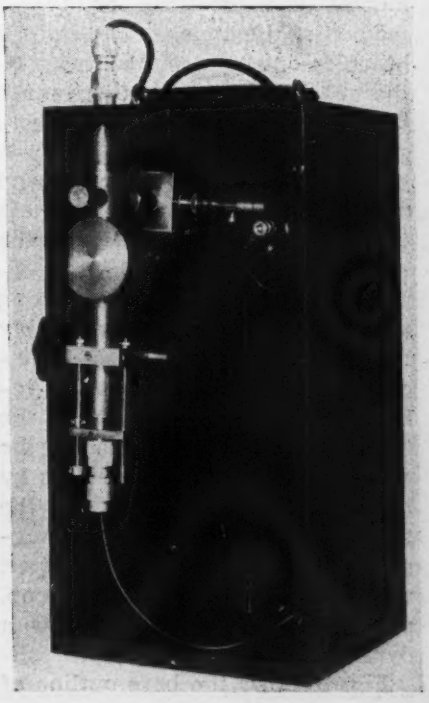


Fig. 10—Mixer assembly detail



Feedback Recording Head Giving Low Intermodulation

By EMORY COOK, Cook Laboratories, Floral Park, N. Y.

Improving frequency response and stability in disc recording by controlling a feedback loop from the last amplifier stage

• In order to round out the audio picture, an improvement in the performance characteristics of disc recording and reproducing equipment is certainly indicated.

The use of degeneration over and around an amplifier and disc recording head is one step in this direction, enabling the wide spread audible improvement of standards with existing disc recording tables and lathes. With careful stylus selection practical values of 1% 60/6000 cycle intermodulation are easily attainable in playback at a 60 cycle level which fills the groove at 96 lines per inch.

If, from a standing start, one decides to build a feedback record cutter, and surveys the field correspondingly, he soon sees that he must choose between three fundamental configurations or types: *magnetic, dynamic,* or *crystal.* If he rules out crystal arbitrarily on the basis of past performance (something which may not necessarily hold true in the future), there remain only magnetic and dynamic. In a choice between these two, economy finally plays the major role; more weight of permanent magnet, more machining to closer tolerance, more assembly time, coupled with increased difficulty of design due to an inherently greater fragility of the dynamic structure, place the dynamic cutter in a price class by itself. With due regard for the things that matter, the 4-gap magnetic structure in a record cutter, when included in a feedback loop, probably does just as well as a dynamic structure anyway.

Fig. 1 shows the bare outline of a magnetic cutter. It is primarily a magneto-mechanical differential device where four air gaps, A, B, C and D, all carrying audio flux, act to move the armature about a pivot point. Fig. 2 shows the outline of a common lifting magnet such as might be used in industrial work.

STANDARDS of performance in broadcast audio installations are now, and have been for some time at what is probably the ultimate, or close to the ultimate, point—they are not likely to go much higher than they are right now. These standards, as set forth by the various qualified bodies such as FCC, NAB and others, have been largely theoretical standards, however. Most engineers practicing in the field will readily agree that they are seldom reached and sustained in a given location for any length of time. However, practice is conforming to these standards more and more every day; even in the home receiver field, standards of performance are unquestionably very high and improving rapidly.

The expression for the force exerted across the gap is $f = K B^2 A$, where B is the flux density in the gap, A is the area of the gap, and K is a constant, depending upon the units used. In applying this formula to the configuration of the four air-gap cutter, a simple mathematical exercise will show the resultant force exerted on the armature to be proportional to the first power of B instead of the second power, if the amplitude of movement is small compared with the size of the gap.

Thus, in order to produce a sinusoidal movement from a sinusoidal electrical source, a sinusoidal flux must exist in the gap. Without feedback, and with practical existing magnetic materials, a sinusoidal flux will definitely *not* result from a sinusoidal current in the driving coil in this type of cutter, especially at high flux density, and inasmuch as these devices are always operating at high flux densities, the discrepancy between NI (ampere-turn) wave shape and flux wave shape is ordinarily severe enough to cause intermodulation far in excess of that allowed in the other branches of the audio family.

If by winding many turns of fine wire around the pole pieces of Fig. 1 at points E and F, we can feed back a voltage proportional to the rate of change of audio flux in the gap, we will force the driving amplifier to compensate in advance for most of the non-linearity of the magnetic materials, and maintain the wave shape of the useful flux in the gap directly proportional to the electrical input of the amplifier until saturation of the magnetic material or the amplifier (or both) is reached.

We are then assured a *force* proportional to the electrical input signal; providing the centering spring of the cutter is linear and providing the pivot bearing fric-

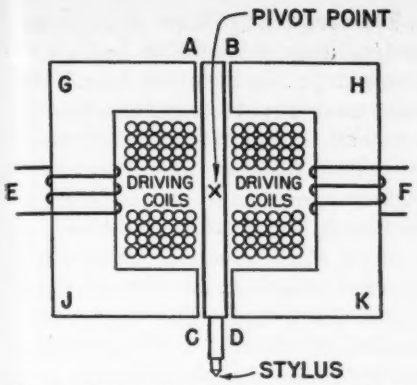


Fig. 1—Schematic outline of magnetic recorder

tion is inconsequential, we shall then have a movement of the armature which is proportional to the electrical input signal of the amplifier. It is necessary and vital to go to great lengths to maintain a linear system of centering springs where as far as the spring is concerned, F will really equal kD; and to design the pivot point or knife edge in the most careful way.

The use of feedback in any device, most of all this one, however, should not be viewed as a panacea for all evils inherent in design or in materials. In other words, feedback should not be hauled in by the heels in an attempt to make a "limousine" out of a "flivver", but enlisted instead to help a limousine to be a good limousine, or even to help a flivver to be a good flivver.

With this in mind, the amplifier used to drive the cutter, and which is of course included in the feedback loop, is inherently a low distortion, wide frequency range device; the magnetic materials chosen for the cutter are the best obtainable for the purpose. The material known as Permendur has the highest saturation flux density of any magnetic material now available, and maintains its ac permeability in the face of a polarizing dc flux, a characteristic notably lacking in most magnetic materials and exactly what is required here.

Feedback Kaleidoscope

The writer believes that there has been a number of previous attempts to surround magnetic cutters with feedback loops, many of which have met with no success. There are a number of separate reasons why it is not easy to close a feedback loop around a device of this sort, and a complete enumeration of the pitfalls could hardly be anything more than depressing. Perhaps the most illuminating channel of thought to explore would be that of phase relationships, for it is in this department that many previous attempts have probably failed.

It is rather old in the art to use

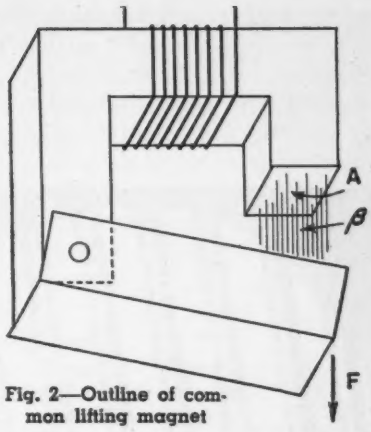
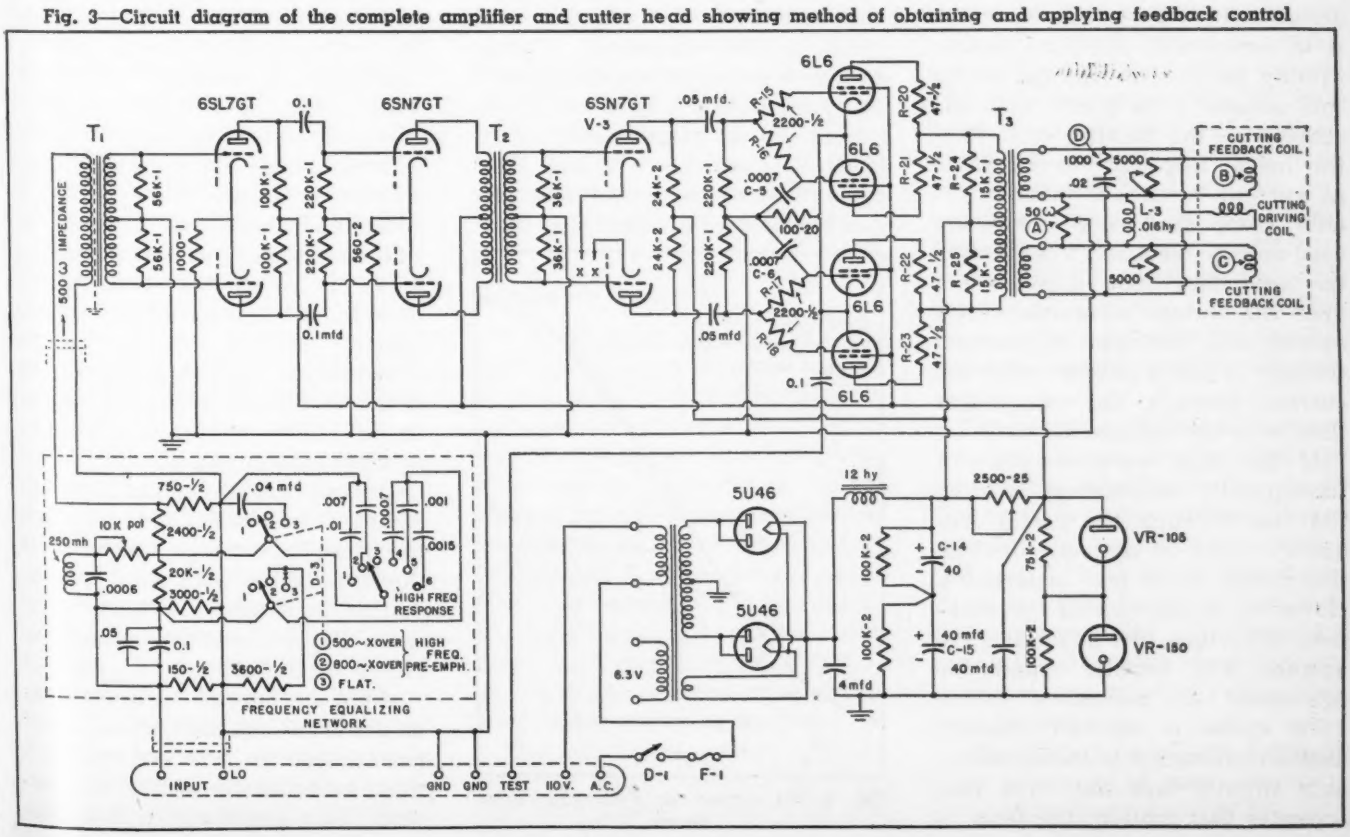


Fig. 2—Outline of common lifting magnet

two loops when it is necessary to feed back over a complicated or multi-stage amplifier. The inside or secondary loop is usually found to include a smaller number of stages or circuit elements than the outside or primary loop. The inside loop will often be characterized by a relatively small gain loss or A B product, and is merely for the purpose of straightening out the phase characteristic of that smaller number of stages so that this portion of the amplifier or system is much better than the remaining portion of the amplifier which is then finally included in the primary or outside loop. This primary loop then exercises full control on the amplifier characteristic.

The principle is equally applic-

Fig. 3—Circuit diagram of the complete amplifier and cutter head showing method of obtaining and applying feedback control



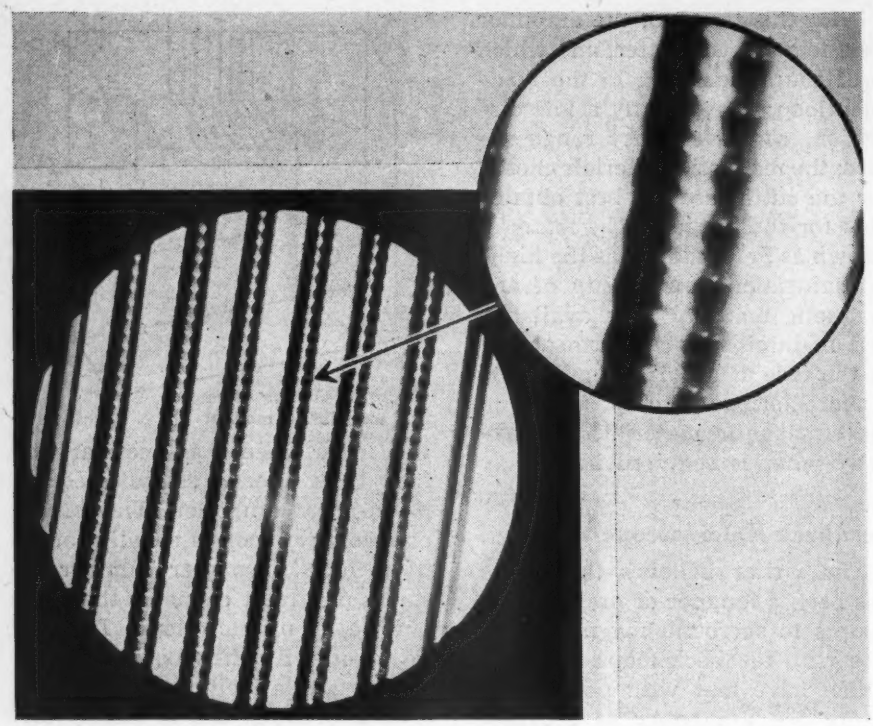


Fig. 4—Photo-micrograph of a groove cut at 12,000 cycles at a diameter of 16 in. at 33 rpm, corresponding to about the middle of the playing range of a 10-in. 78 rpm record

able to electro-mechanical devices; —the recording head here described—and in order to straighten out the phase relationship characteristic of the amplifier itself a secondary or inside loop is used. The novel feature of this loop lies in its derivation from the amplifier output signal.

Feedback voltage is developed across a resistor (A, Fig. 3) which is in *series* with the load (cutter driving coil). The voltage across this resistor is *in phase* with the current in the driving coil. Thus the inside loop may be classified as *current* feedback, distinguishable from the more commonly used voltage feedback. Feedback in the secondary loop depends not upon the voltage across the cutter driving coil, but upon the current through it, and is *in phase* with the current through the coil rather than with the voltage across it.

If the load were resistive or substantially resistive, as is often the case through the useful frequency range of dynamic devices, this would be of less importance. However, in the case of the magnetic structure, the inductive reactance will usually equal the equivalent dc resistance before 1,000 cycles is reached. Plainly, mechanical motion of the armature only slightly lags the force that activates that motion; the force is in turn in phase with the current (NI) in the cutter driving coil.

If, therefore, we make current in the cutter driving coil conform in phase to the amplifier electrical input signal, we have the advance requirement for a stable overall outside loop to be applied from the flux measuring coils (E and F) located at the cutter pole pieces to the amplifier input. As we have seen, if the customary *voltage* feedback were used in the secondary loop it would give us an inherent initial phase error of at least 45° before we reach 1,000 cycles, and at the higher frequencies would inhibit stable operation.

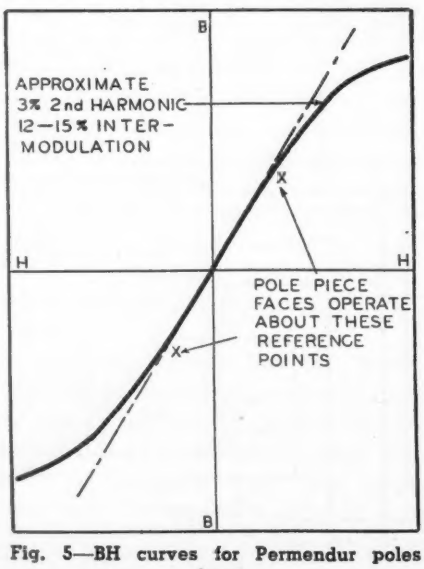


Fig. 5—BH curves for Permendur poles pieces

The frequency range of an audio system always seems to be of extreme importance to the user. Perhaps more importance is sometimes attached to this characteristic than is warranted; an *adequate* frequency range for most purposes is ordinarily much to be preferred to a *more than adequate* range, for obvious reasons. In the field of sound recording, this statement cannot be ignored with impunity. Standards of rpm, stylus shape and size, instantaneous blank coating material, and many other separate factors all combine to make the extending of useful frequencies difficult and impractical beyond a certain point. With a few playings of heavily modulated passages containing high energy levels at high frequencies, thermoplastic pressings and lacquers exhibit cold flow, and shellac pressings become severely chipped. Fig. 4 is a photomicrograph of 12,000 cycles as it appears at a 16 in. diameter at 33 rpm. (This corresponds to about the middle of the playing range of a 10 in. 78 rpm record).

Frequency Limits

Obviously the linear dimension along the groove of a single cycle is already so small compared with the width of the groove and the stylus size that frequencies higher than this will probably give us trouble, especially at smaller diameters where the linear speed is less. Generally speaking the actual recording of high energy content high frequencies of the order of 12,000 cycles and above will in the practical case result only in an effective widening of the groove, rather than in useful playback information.

Therefore, the frequency limit of this feedback system was chosen to be 12,000 cycles with an extremely sharp cut-off above this frequency. On the other hand, it is not at all difficult to increase the frequency range available at the stylus tip of the cutter, and the matter is merely brought up to show the philosophy behind the 12,000 cycle limit.

If the mechanical damping is removed from any mechanical motor device such as a record cutter, a main resonant frequency will appear. This frequency will be de-

termined by the effective mass moment and mechanical spring reactance of the mechanical system. This resonance point will usually be found to lie between 1,000 and 4,000 cycles in most magnetic cutters, and in the case of this particular cutter is at approximately 2,000 cycles.

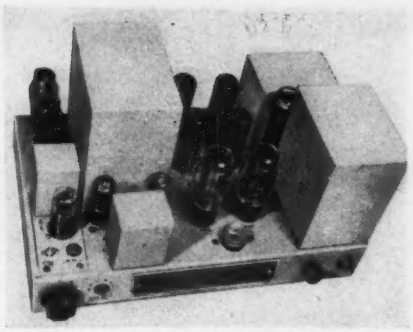
At frequencies below the resonant frequency, the mechanical system is "spring loaded", just as when an electrical tuned circuit is on the capacitive side of resonance. Throughout this range (0 to 2,000 cycles, approx.), the frequency response of the amplifier-cutter system will be under the control of the feedback loop, even though the mechanical damping is attached.

Mechanical Damping

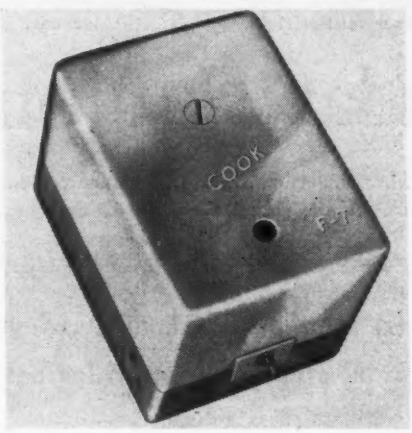
Above the resonant frequency, response of the stylus is less and less under direct control of the feedback loop, since the mechanical system is then "mass controlled". That this should be the case will not be a disadvantage if some equally proficient control of frequency response may be substituted for the feedback.

Mechanical damping serves to control frequency response very effectively if the right damping material is used, and providing it is shaped properly and coupled to the mechanical circuit in the right way. The damping will then completely level the main resonance of the mechanical circuit in the right way. The damping will then completely level the main resonance of the mechanical system and act as a special kind of mechano-acoustical transmission line at progressively higher frequencies, sometimes absorbing, sometimes storing and restoring energy to the moving system to produce a uniform response.

If no secondary mechanical resonance at a frequency higher than the main resonance of the system occurs, then the mechanical system, even though damped, will be essentially mass controlled at all frequencies higher than the resonant frequency. Since this is the case, there is no predisposition toward high frequency non-linear distortion anyway; therefore feedback distortion correction is unnecessary. The overall (outside)



Upper view shows appearance and arrangement of the amplifier. Cutter head shown below



flux loop acts to inhibit non-linear distortion from the lowest frequency up to and slightly beyond the resonant frequency. Both outside and inside loops act to correct electrical and flux intermodulation between any two frequencies, as long as one of the frequencies is near or below resonance. Cross-modulation between two frequencies higher than resonance cannot very well occur in the amplifier itself due to the secondary loop, and cannot occur in the cutter because it is then mass-controlled.

Frequency Response

It is not at all difficult, with the four air gap configuration shown in Fig. 1 to obtain a frequency response uniform to within 1 db of the desired characteristic through 12,000 cycles. Stability of the response below resonance will be the responsibility of the feedback loop; stability above the resonance is mainly a matter for the damping department, and for this reason great care must be exercised to choose a time stable and temperature stable damping material.

The amplifier shown in (Fig. 3) is a four stage-push-pull unit using four power tetrodes in the output stage. The last two stages of the amplifier are involved in the feedback loops and the application of feedback to the magnetic cutter results in a pure velocity device. Therefore, in order to produce the required recording frequency characteristic, equalizing networks must be placed ahead of the feedback loop. These are shown in Fig. 3 at the lower left of the diagram.

Three available characteristics are made possible through the use of switch D3 in this network, as indicated. Since in passing through the frequency equalizing network, the signal is severely attenuated at the lower frequencies to produce the required recording characteristic, the signal-noise ratio has placed upon it an 18-20 db handicap. An extremely low 60/120 cycle noise level must be maintained throughout the amplifier. For this reason, transformers T1 and T2 are highly shielded magnetically and of balanced or "hum bucking" construction.

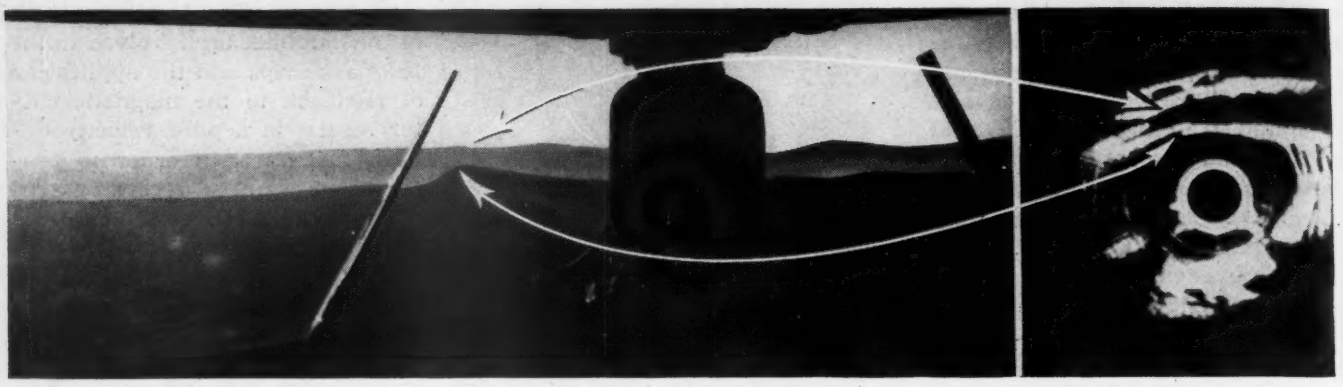
Choice of Tubes

The use of push-pull rather than single-ended construction throughout simplifies the problem of noise arising from power supply ripple. Neertheless, it is convenient as well as economical to use voltage regulator tubes to supply the first two stages and the screens of the output tubes. The 6SL7GT tube is chosen for high voltage amplification; type 6SN7GT must have a reasonably low plate impedance to operate effectively into the interstage transformer T2. The second 6SN7GT must have a rather high gain or amplification factor in order to enclose in the AB loop the largest possible amount of *A*.

The output stage has 6L6 power tetrodes without the disadvantages sometimes occurring in the use of this tube for audio purposes. Power tetrodes and pentodes are characteristically high plate impedance tubes and may therefore be classified substantially as "constant current" generators when they are operated into relatively low plate load impedances.

The placing of *voltage* feedback over this type of tube, especially

(*Continued on page* 99)



Under conditions of good visibility the pilot would see the nearest hills, about 3 miles distant, a valley and two more ridges. How these appear in the 'scope presentation is shown at the right, illustrating from the center out, the transmitted pulse (main bang), altitude circle, marker circles at 2-mile intervals, and ground echoes. Plane is moving toward top of page

Airborne Radar Equipment Design

By L. H. LYNN, Section Engineer, Aviation & Marine Eng.,
Electronics Dept. General Electric Co., Syracuse, N. Y.

Light-weight pressurized transmitter-receiver, developed from military experience for commercial airplanes, provides seven essential services

• Early in 1944 the Army Air Corps requested a new type of airborne equipment, which would have many of the characteristics of previous installations, but which would be considerably simpler and lighter. The specifications stressed reliability, ease of installation, operation and maintenance, low power drain, low weight, and ruggedness.

General Electric Co. and Radiation Laboratory engineers rushed through an intensive development program, and flight tested the AN/APS-10 prototype in June 1944. This equipment was the answer to the Air Corps' request. While final "de-bugging" went on, the production wheels were started and the first equipments rolled off the line in the early spring of 1945, at General Electric's Electronics plant in Syracuse, N. Y.

Before an appreciable number of installations could be made, the war ended. Operational experience was obtained, however, aboard planes of the Air Transport Command, where the "land-painting" and beacon-recognizing functions of the APS-10 were invaluable aids to air navigation.

The military requirements for this equipment listed seven major uses, all of which are applicable to the needs of commercial airlines.

1—Land-painting: (Long range recognition of prominent topographic outlines)
2—Distant radar fixes: (On cities, mountains, islands)
3—Nearby detail: (Airports, rivers, shorelines)
4—Coded beacons: (For instant, accurate fixes)
5—Altitude: (Approximate)
6—Drift angle.
7—Ground speed.

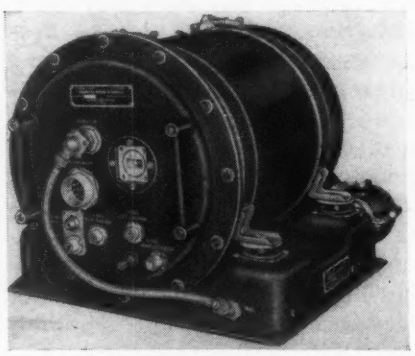


Fig. 1—Pressurized transmitter-receiver unit

Fig. 2—Close-up of front panel of synchronizer unit showing adjustments

In order to accomplish these objectives and stay within the specified design parameters, considerable ingenuity was exhibited, and many design innovations were required.

For example, in order to save space and increase reliability, the basic rf circuits are built into a pressurized aluminum cylinder, (Fig. 1.) which is capable of quick replacement by maintenance personnel in case of trouble. Included within this unit are sub-assemblies for generating, transmitting and receiving the pulsed energy. All connections to this cylinder are through air-tight fittings.

Pressure (slightly above sea

Fig. 3—Complete antenna assembly

level atmospheric) is maintained by a small compressor which pumps air through a renewable dessicator cartridge, thus eliminating the problems arising from rapid altitude and climatic variations. This system also has the twin advantages of keeping out dirt and of preventing high voltage breakdowns at high altitudes.

Components for the range, marker sweep, trigger and control circuits are contained in the synchronizer unit shown in Fig. 2. On the panel of the synchronizer are the essential operating controls, plus secondary calibration adjustments under a hinged cover.

Though necessarily compact for aircraft installation, this unit avoids the usual effects of crowded assemblies by an arrangement which permits "unfolding" of the terminal strips carrying most of the small capacitors and resistors. When it is realized that the synchronizer is only 7 x 9 x 12 in., and contains 25 tubes with associated components, it becomes apparent that design tricks of this nature protect the sanity of many maintenance men.

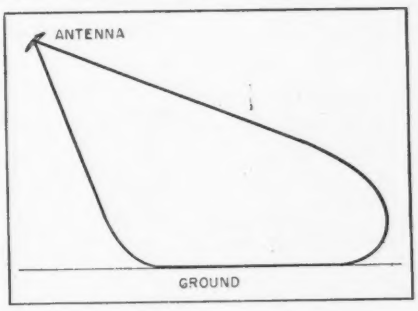
The 3 cm. pulsed signal from the 7 kw magnetron of the transmitter/receiver cylinder is carried through waveguide to the antenna assembly of Fig. 3. Usually located in a plastic radome below the belly of the plane, the parabolic spinner rotates at 20 rpm. A separate motor-driven mechanism, controlled by the "TILT" switch on the synchronizer panel, permits the angle of scan to be depressed below the horizon. This adjustment allows the operator to select the optimum search angle dependent upon his altitude, distance from the target or nature of terrain.

Antenna Pattern

An unusual feature of the modified parabolic antenna reflector is its "cosecant squared" pattern, outlined in Fig. 4. It will be noted that though the beam is narrow in the vertical plane, it covers a lot of ground in the horizontal. Thus uniform signal strength is received from ground objects over a wide range of distances from the plane. This beam shape also assists in maintaining relatively constant response even though the altitude of the plane varies a few degrees.

Dry air from the compressor-dessicator unit not only keeps the transmitter/receiver unit under pressure, but also the waveguide and the plastic ball covering the dipole assembly located at the

Fig. 4—Cosecant squared antenna pattern



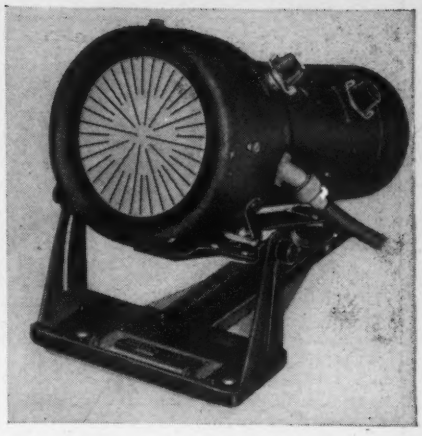


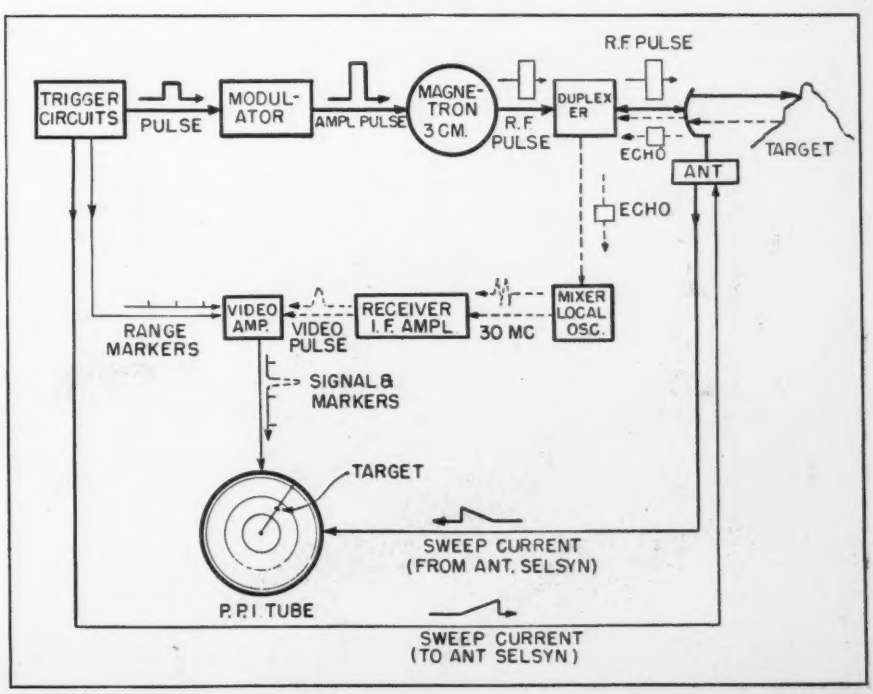
Fig. 5—Close-up of pilot's indicator unit

focal point of the parabolic reflector.

One of the interesting problems of antenna design was to pipe the rf energy plus the pressurizing air through the waveguide and antenna system, yet permit the reflector assembly to rotate and to tilt. This was solved by special fittings which first convert the rectangular to round waveguide located on the axis of antenna rotation, thence back to rectangular guide the rest of the way to the dipole. This latter run is broken by a tilt joint which permits a few degrees of rocking motion, at the will of the operator.

The fourth major unit is the indicator, which contains the 5 in. cathode ray tube and its controls. Although normally located for the

Fig. 6—Functional diagram of APS-10 airborne radar unit showing relationship and operation of all units



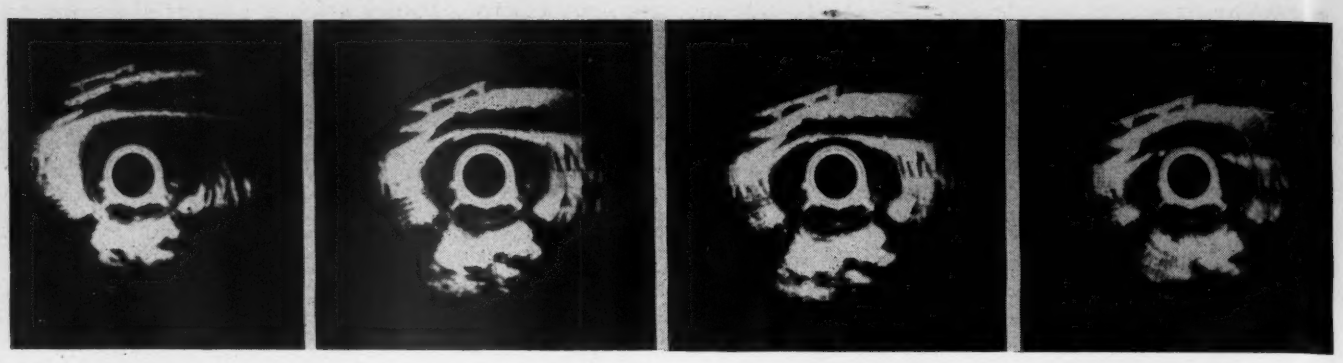


Fig. 7—A—Altitude ½-mile, nearest hills indicated as 3 miles distant

B—First row of hills within 2-mile circle, and definitely a hazard

C—Half a minute later ridge apparently "dissolves" into cone of silence

D—Skimming over the ridge and beginning to study the next ridge

convenience of the navigator/radar operator, it may be duplicated at the pilot's position. Again extreme compactness is featured, as may be seen in Fig. 5. The shield surrounding the PPI tube also includes three miniature tubes, deflection coils for the sweep circuit, brilliance, focus and dial light controls. In spite of the high density of this unit, accessibility is good, since the removable case exposes parts for replacement or service.

An unusual focusing system is used, involving an annular magnet of Alnico, surrounding the neck of the cathode ray tube. By means of a movable iron shunt, coaxial within the Alnico annulus, varying amounts of leakage flux are caused to cut through the neck of the cathode ray tube, thus producing a magnetic lens, which focuses the beam. This eliminates the need for constant current circuitry required coil, and is independent of heating or line voltage fluctuations.

Picture "Painting"

Beam deflection voltage for the sweep line (which "paints" the radar picture) is obtained from the synchronizer unit, impressed upon the rotor of the antenna selsyn, whence it sets up a rotating field in the 3-phase stator. This is connected to the similar stator surrounding the PPI tube, and thus causes the sweep to rotate in exact synchronism with the antenna.

The remaining major unit of the APS-10 is the rectifier power unit, which supplies a variety of operating voltages for the synchronizer and indicator units, including the 4000-volt supply for the cathode ray tube.

Primary power for the APS-10 for the usual type of wound focus is taken from the 28-volt dc line, and 115 volt, 400-1600 cycles from the plane's generator. Total drain from these sources is only 400 watts. Figure 6 is a functional diagram of the basic circuits.

The Navigator wishing to use the APS-10 need only be equipped with the standard number of hands, a fact which makes this equipment unique among military search radars.

Power is controlled by the power switch on the synchronizer panel of Fig. 2, and after a three-minute automatic delay for tube warm-up, the equipment is ready to operate.

RANGE is selected by the knob so labelled, and is continuously variable from 4 to 25 nautical miles. A fixed 50-mile range is available for longer search problems, and is about the normal limit for the relatively low-powered (7kw) transmitter.

Two longer range positions of this control are available: 90 and 70-160 miles. Selection of either of these presupposes that the operator desires to receive coded radar beacons, since it is not probable that radar echoes would be received at this range. The 70-160 mile range is so arranged as to start measuring distance with 70 miles as the starting point, at the center of the picture. Beacons also may be received on the 4-25 and the 50-mile ranges by moving the SEARCH/BEACON switch (Fig. 2) to the proper position.

Distance is indicated by electronically generated marker circles, which appear at intervals varying from 2 to 20 miles apart depending upon the RANGE selected. Brilliance of these circles

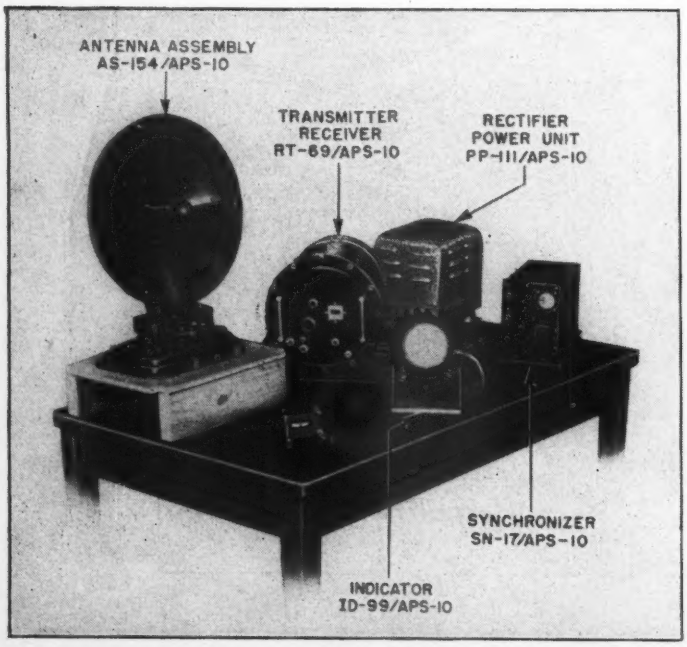
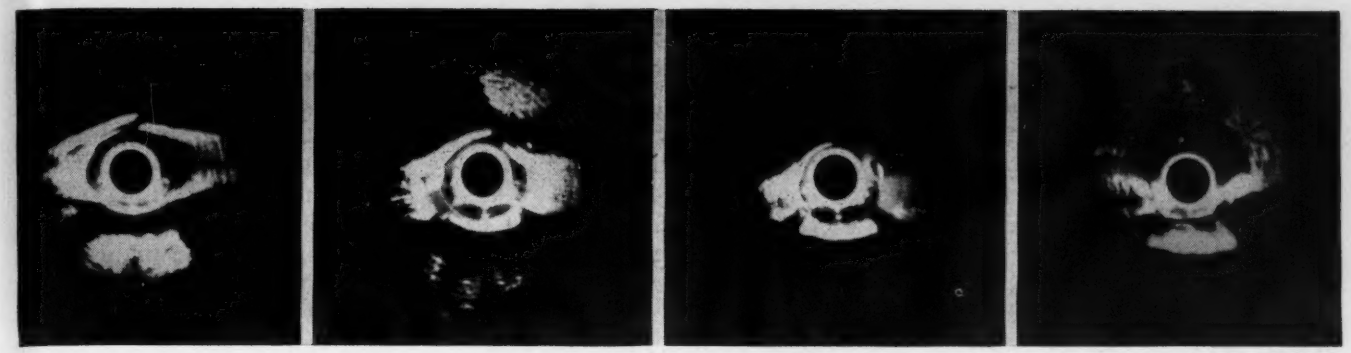


Fig. 8—The several units that go to make up the complete APS-10 airborne radar equipment, showing their relative size and approximate space and weight requirements



E—Plainly shows gap in ridge, toward which plane is now moving

F—Plane now passing safely through the opening in the last ridge

G—Plane has now passed through the gap and heads for open country

H—Indication now shows that there is nothing ahead but clear, level terrain

is adjusted by the knob labeled MARKER BRILL.

Antenna TILT is capable of variation by means of a spring return toggle switch shown on the synchronizer panel, while an indication of tilt is registered by the pointer on the same panel. Here again, the operator was given a break, for instead of calibrating this indicator in degrees, and introducing trigonometry into the problem, the markings are in thousands of feet altitude, up to 30,000 ft.

Proper selection of antenna tilt gives the operator a choice of studying distant targets to the exclusion of local ones, or vice-versa, which appreciably simplifies the PPI presentation.

Altitude is normally registered on the scope as a bright ring not too unlike a marker circle, since enough stray energy is radiated outside the cosecant squared antenna beam to produce a sizable echo. At very high altitudes, where stray radiation may not be sufficient, the operator may read altitude by depressing the antenna downwards a few degrees, until sufficient echo is received.

The remaining knob on the synchronizer panel is the GAIN control which adjusts receiver sensitivity. As in all radar sets, skillful manipulation of this control makes the difference between a good and bad presentation, for excessive gain results in a cluttered picture.

The same may be said for the BRILLIANCE control on the indicator unit, which is the last operating knob on the list. Proper combination of these two adjustments comes after a few hours practice.

As soon as military restrictions permitted, American Airlines installed an APS-10 equipment on Flagship "Alpha"; later, in conjunction with General Electric engineers, a second unit was placed on the Flagship "St. Joseph". Under the direction of R. W. Ayer of AAL, a series of operational tests was instituted, the "Alpha" operating out of New York and the "St. Joseph" on the Seattle-Anchorage run.

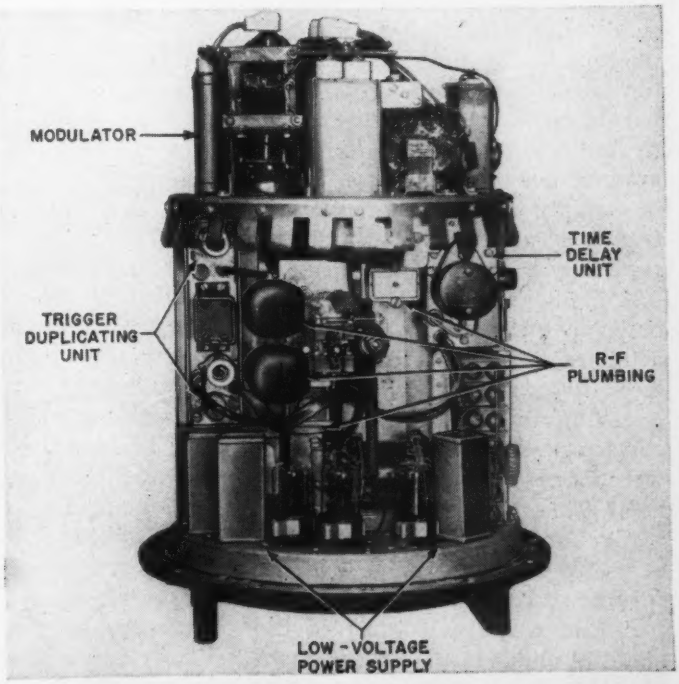
Non-Military Adaptation

Scores of pilots were introduced to the equipment and a very wide experience gained both from the standpoint of the personal equation and from the actual flight factors involved. From this field work, it was determined that several modications were required to make the APS-10 suitable for non-military work.

The two major changes involved were on the antenna assembly. The cosecant squared beam was shifted back to the more normal 5° conical shape, and the whole antenna assembly gyro-stabilized. These changes permitted a new approach to the use of radar—the employment of the "Safety Circle" as American Airlines calls it.

By proper selection of the initial tilt angle, the antenna now views a fairly narrow (compared to APS-10) annular ring, in which the shape is unaffected by the plane's attitude, since the antenna is stabilized. The inner radius of this ring may be varied by proper choice of antenna tilt, so that the terrain nature and altitude are properly shown to the pilot.

Fig. 7 is a series of photographs of this type of presentation, showing from the center out, the trans-



Interior view of the transmitter-receiver unit showing compact construction of the equipment and identifying the several essential components

mitted pulse ("main bang"), altitude circle, marker circles at 2-mile intervals, and ground echoes. The plane is moving toward the top of the page in each picture.

From 7a, we can see that our altitude is a little under a half mile and the nearest hills ahead are 3 miles distant. Past this barrier is a valley, then two more ridges. A minute later (7b) the first row of hills has come into the two-mile circle, and is definitely a hazard. A sensible pilot would start climbing at this point, but let's continue on our course and see what the radar tells us.

Picture 7c, after another half-minute, shows the ridge at 1¼ miles, but apparently "dissolving". In other words, it is probably passing into our cone of silence under the plane. Thirty more seconds, and frame 7d shows us just skimming over the hills, and beginning to study the next ridge.

Another minute, and 7e shows a welcome gap, towards which we turn, and pass safely through as in 7f and 7g. In the next shot, 7h, we have left our worries behind, and are proceeding over clear level terrain ahead.

Note the definite advantages of this type of presentation, as contrasted with a mere obstacle detector:

1—The size, range, shape and bearing of the obstacle are clearly shown, enabling an intelligent rapid choice of action.

2—Still available to the pilot is information on ground speed, weather avoidance, drift, altitude, rivers, lakes, islands, etc.

3—Fixes may be obtained from coded beacons, and these may be extended to the marking of landing strips.

4—This information is received at any altitude up to the aircraft's ceiling.

5—Components are used within their safe ratings, which is especially important in non-expendable commercial equipment. (Contrast this design with that of a military "Tail-Warning" radar used on fighting planes. Considered an expendable item, it permitted a miniature tube, rated at 150 volts, to be pulsed at 1200 volts. Frequently this hard-smitten 6J6 refused to stop shuddering after each pulse, and caused the warning signal to flash, in effect "crying wolf".)

Tests with the modified APS-10 are being continued by American Airlines in an effort to gain still more operational experience, so that a purely commercial version may be produced. It is felt that an intensive, logical development program of this sort will result in a radar equipment truly geared to the demands of safe, intelligent flying.

METHOD FOR MEASURING LOW DIELECTRIC CONSTANTS

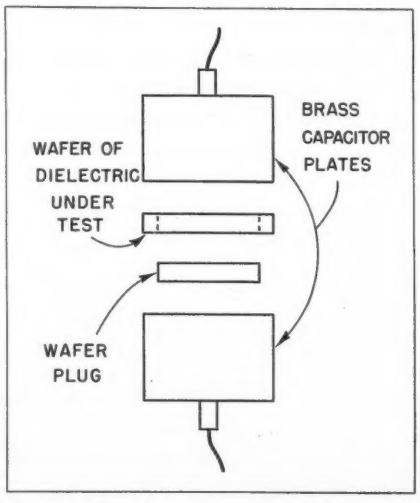
By ALBERT E. NAMEY, Measurements and Standards Labs., Bendix Radio, Towson, Md.

• The measurement of the dielectric constant of materials when the constant is low presents a difficult problem under ordinary methods of measurement. This method has been devised to measure dielectric constants rapidly, yet accurately with ordinary laboratory equipment.

The method was designed to eliminate fringing effect. All appreciable fringing error is introduced and included in the first balance. This fringing effect capacity remains as a constant through the second balance along with the wiring capacity, the spacing capacity and the capacity of fixture to ground. The only cause for change in capacity is the change in dielectric constant of the volume occupied by the drilled material.

A cylinder of brass was turned down to a given dimension (1 in. diameter) with close tolerance, cut into two segments and their matching surfaces were milled and polished. Electrical connections were made to the back of each segment. This matched pair of plates, a jig for holding them and a Schering capacity bridge are the only accessories needed.

A thin wafer (.100 in.) of the material under test is turned down to the proper (1 in.) diameter and milled on both sides to parallel surfaces. A capacitor is then made using this wafer as the dielectric between the two brass plates. The capacity is measured in the Schering bridge. Then a large hole (¾ in. diameter) is drilled in the material and the change in capacity determined. This change in capacity is caused by the change in dielectric constant in the volume occupied by the drilled material. The change in dielectric constant can be calculated, and by adding 1, the dielectric constant of air, the dielectric constant can be determined.



Construction of capacitor plates and wafer plug

$$\Delta k = \frac{\Delta C \times t}{.2244 \times A}$$

Δk = Change in dielectric constant

ΔC = Change in capacity μμf caused by drilling hole

t = Thickness of wafer in inches

A = Cross sectional area of hole drilled in square inches

$k = \Delta k + 1$

If a plug of the same material is made for this hole, having the surfaces milled to the same dimension and of the right diameter for a very tight fit, the reading can be repeated.

An analysis of the area drilled will show that there is theoretically no fringing introduced. The line of separation of the materials (air and material under test) is perpendicular to the electrode surfaces and parallel to the dielectric lines of force. Thus, a homogenous path is provided to any one chosen line of force, giving a uniform potential gradient throughout the field considered.

Design of Electron Lenses

By R. G. E. HUTTER, Sylvania Electric Products Inc., Flushing, N. Y.

Use of electrolytic tank facilitates tracing and charting electric and magnetic field distributions in scale models

• The study of electron paths through electron lenses and electron prisms is essential if instruments in which they are used may be expected to achieve the high quality of light optical instruments. High resolving power electron microscopes, clear, undistorted television images and reliable radarscopes can be designed only through a thorough study of the behavior of electron lenses.

The first step is to obtain exact data on the electric and magnetic field distributions. Mathematical methods are adequate for determination of field distribution patterns for only a limited number of types of electrode shapes or coil forms. Both electric and magnetic fields, however, may be determined experimentally and with sufficient accuracy by means of an electrolytic tank.

The tank is an analogue device containing counterparts of the electron lenses and prisms used in cathode ray tubes and similar devices. Thus when tank electrodes are immersed in a slightly conducting liquid, such as water, electric current distribution is produced identical with electric field line distribution in the vacuum tube. If electrodes are scaled up by a factor k the field or current distribution will also be scaled up by factor k.

Determination of field distribution of an electron lens is made by preparing large scale models of the electrodes and immersing them in the electrolyte. When potentials with ratios corresponding to those of the electron lens are applied to the model electrodes, current will flow through the electrolyte. Lines of equipotential can then be determined by means of a probe placed in the electrolyte, and a vacuum tube voltmeter.

A double carriage system provides a means of moving the probe across the electrolyte in which it is dipped to a depth of a few millimeters. Motion of the probe is translated to a writing pen by means of a rigid arm. The pen is suspended by an electromagnet and may be released by push button on the front side of the tank. The vacuum tube voltmeter is preset to read zero for a given probe voltage. The operator moves the probe in rapid small steps to maintain zero meter reading. The pushbutton is pressed at every step to record points along equipotential lines. By changing the vacuum tube voltmeter setting, different equipotential lines are traced so that complete field distribution may be determined in a relatively short time.

Some applications require determination of simultaneous potentials at five different points which may be provided through the use of five vacuum tube voltmeters connected to five probes.

The electrolytic tank in operation, showing method of moving the vacuum tube voltmeter probe in order to obtain, with a writing pen, a picture of field distribution

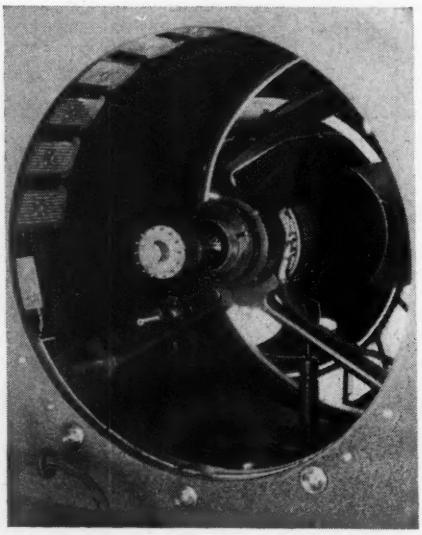
EXPERTS AT NAB ENGINEERING CLINIC—Left to right: John Willoughby, FCC assistant chief engineer; Curtis Plummer, FCC television chief; James Barr, FCC AM chief; Cy Braum, FCC FM chief; George Sterling, FCC chief engineer; Royal V. Howard, NAB director of Engineering; Orrin Towner, WHAS, Louisville; Dixie McKey, consulting engineer; George Adair, consulting engineer; O. B. Hanson, NBC vice-president in charge of engineering; G. B. Houston, WCBM, Baltimore

Television Topics Dominate NAB Technical Conference

Engineering sessions study theater screen projection, direct photographing of TV images from tube face — Discuss FM Propagation systems

• Television dominated the engineering conference portion of the 25th annual National Association of Broadcasters convention in Atlantic City, Sept. 15-18. Most of those who attended saw for the first time the possibilities of really large screen television projection designed for theater operation and developed and demonstrated by Radio Corp. of America engineers. And they were let in on at least some of the technical details and the equipment which has been the result of considerable concentrated study and experimentation.

For the demonstration RCA had set up the equipment in the Ambassador hotel; for programs they had enlisted the cooperation of the American Broadcasting Co. and the National Broadcasting Co. with its affiliates WFIL-TV and WPTZ the Philco station. Programs originating in New York were beamed by microwave relay to Philadelphia and thence to Atlantic City where they were put on a 6 x 8 ft. theater screen.



Close-up showing developmental high intensity tube used in RCA theater television projection system

Six relays units were used to get the signals from NBC's station WNBT atop the Empire State Building in New York, to the seaside resort. Signals went from New York to Mt. Rose, to Wyndmoor, Pa., to an RCA relay on the Lincoln Liberty building in Philadelphia, to special RCA relays at Blue Anchor and Batso, N. J. and thence to Atlantic City, in one of the longest relays attempted for TV transmission.

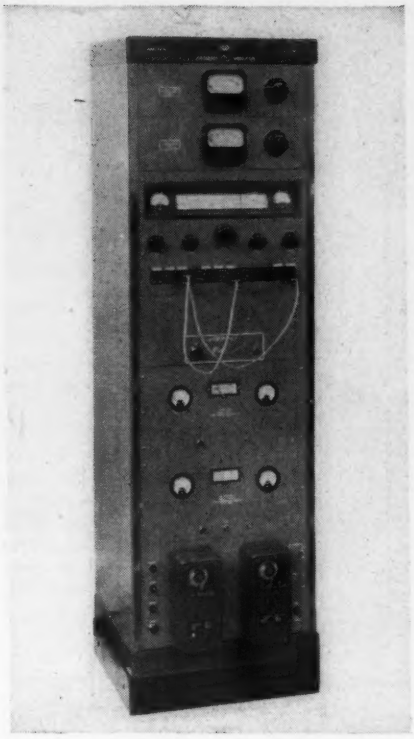
The projection system used in the new equipment is the familiar Schmidt arrangement with a number of modifications. The quality of screen illumination provided is comparable to that obtained with a conventional f2 projection lens though the amount of light reaching the screen is six or seven times as great.

The optical system of the projector consists of two elements—a 21

in. spherical mirror and a 14 in. aspherical correcting lens—mounted vertically in a tubular housing. A 7 in. metal-backed, high-intensity developmental projection tube is placed in such a position that its face is directed toward the magnifying spherical mirror, which is pointed at the projection screen. The large spherical reflector greatly magnifies the picture picked up from the face of the projection tube and projects it through the 14 in. aspherical lens onto the beaded screen, giving an enlargement of about 16 diameters.

The projection tube was specially developed by RCA for use in reflective optical systems. Into this projection tube was designed a metal-backed screen having new types of phosphor compounds. In order to obtain light of proper brilliance for projection, extremely high acceleration voltage is required, in this case 50,000 volts. In addition, a new type of electron gun and other elements have been developed to withstand the very high current used by the projector. The result is a tube which produces a brilliant white light nearly as dazzling to the eye as that of an arc lamp.

The developmental tube, the reflective optical system, and the



REL's new TTL (transmitter-transmitter-link) equipment for off-the-air pickup in FM network operation

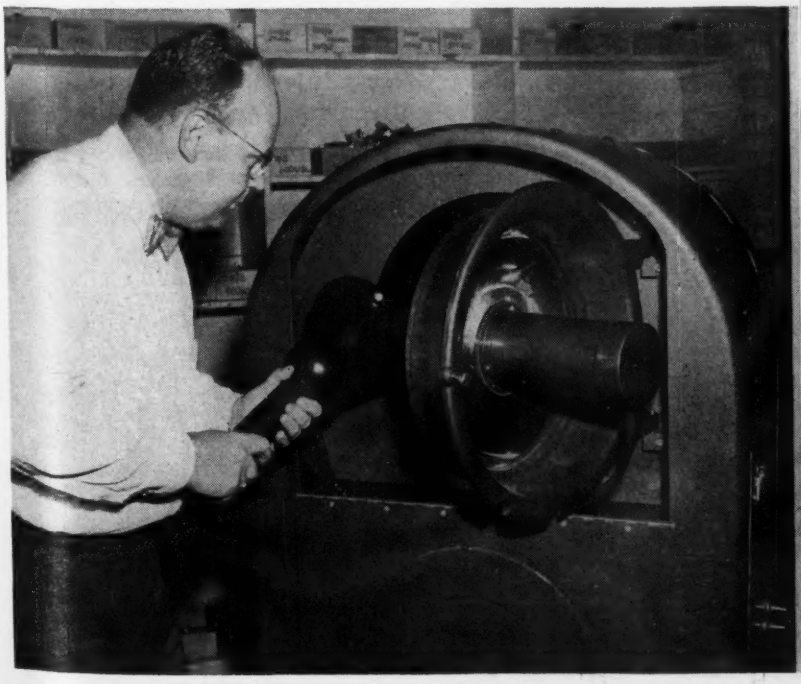
necessary power supplies and control equipment are all self-contained in one unit. While the projector is designed for fixed focus operation, the various operating controls which are mounted on the unit, permit the operator to adjust the brightness, focus, and the framing of the projected picture.

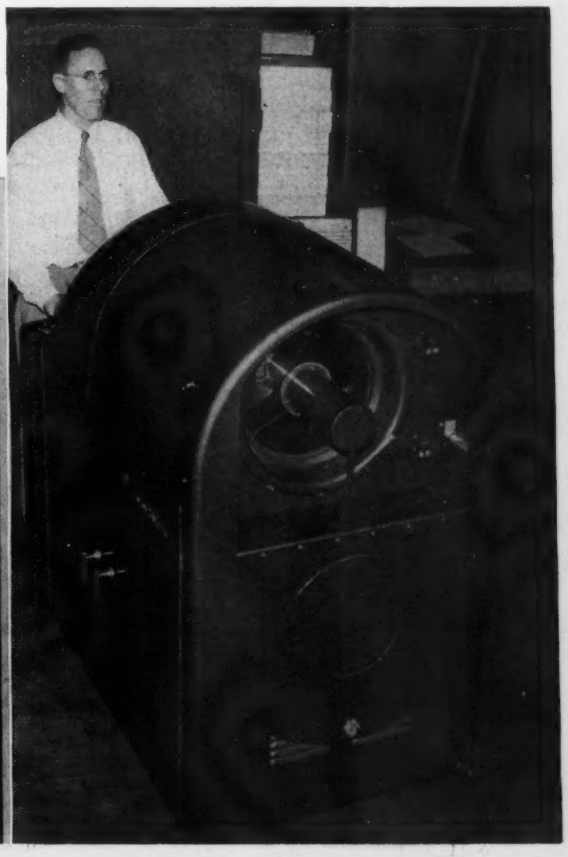
A new type of power supply has been developed which eliminates the danger usually present when high voltages are used. A high frequency oscillator power supply used, instead of the conventional 60 cycle type, prevents the storage of high voltage in the filter circuits, and thus eliminates the potential hazard to operating personnel.

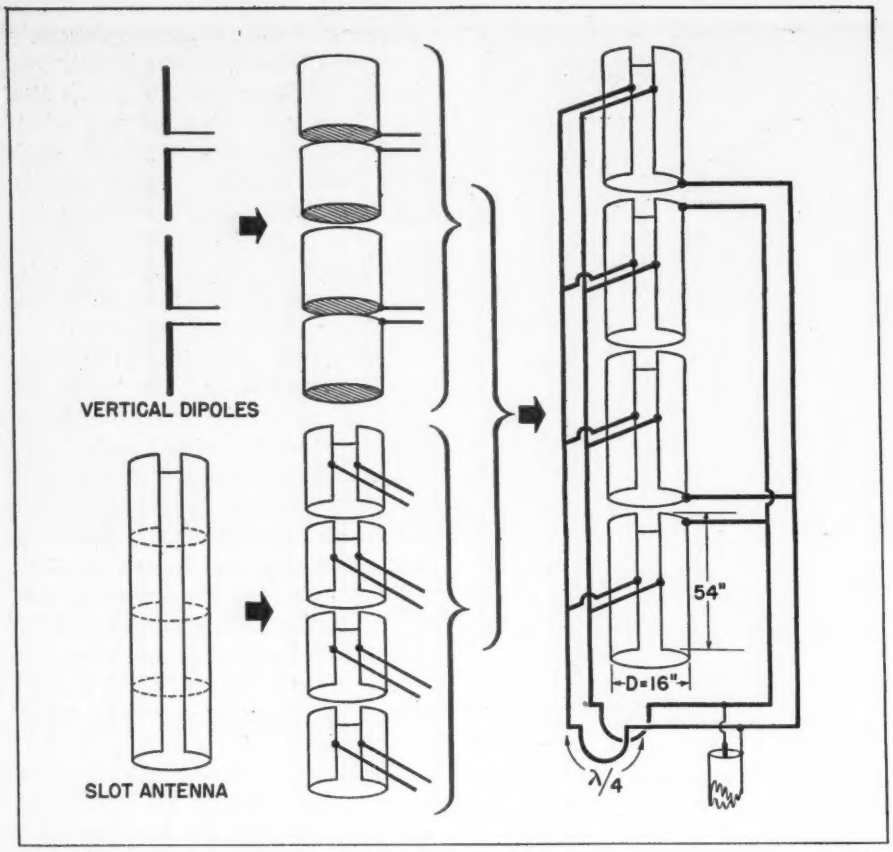
The audience showed considerable interest in a talk by O. B. Hanson, NBC vice-president in charge of engineering in which he described new technics being used for subsequent broadcasting of news pictures and the like by photographing the image directly from the face of the tube and developing the negative material by a new rapid-processing method developed by Eastman. What is produced is virtually a video transcription.

Specially designed cameras are used to shoot studio TV screens as the original program is being telecast. No film editing or cutting is necessary, thus saving much time in distribution. The video transcriptions thus processed are considered good enough for retelecast since studio pictures are made from 8 mc bandwidth equipment, but only 4 mc BW is allowed for

Two views of the new RCA theater television projection unit showing its general construction and the manner of inserting the special high-intensity tube. Equipment projects pictures to a special screen measuring 6 x 8 ft.







Sketch showing evolution of new type 100 mc FM antenna designed to give circular polarization by a combination of vertical dipoles and slot sections

picture transmission.

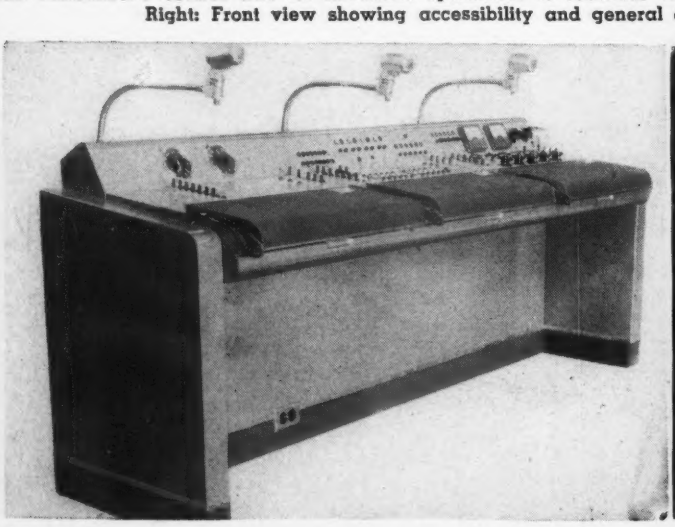
Paul de Mars, formerly of the pioneering Yankee FM network, stressed the need to dispense with empirical formulas which deny experimenters a realistic view of the FM picture. In particular, he deprecated such matters as a smooth earth or line-of-sight in dealing with propagation problems. The terrain over which the signal passes generally is not smooth, but in many cases rough and hilly. Approximation of the behavior of signal coverage in such regions can be made to come closer to reality than assumptions based on a smooth earth.

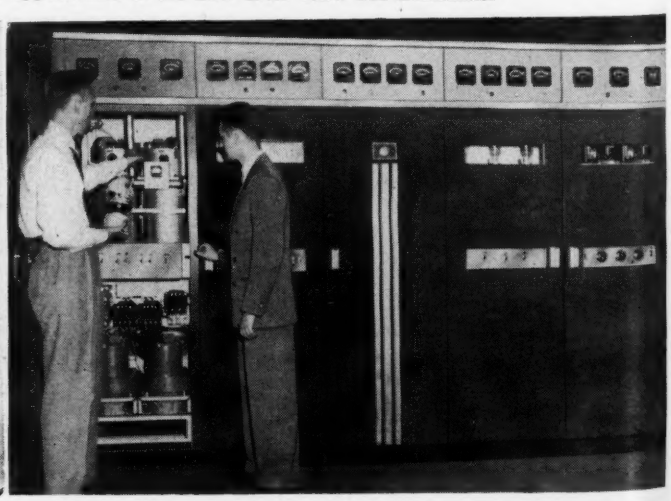
ABC audio facilities engineer, John Colvin, described recent advances in studio equipment. One of these is the specially designed console fader which accommodates a microswitch. The switch may operate a relay which turns on the mike circuit and simultaneously turns off the loudspeaker. This saves switches and wiring and allows lower consoles for better visibility. It also saves the operator time and possible confusion since only one control is handled to accomplish three operations in the correct sequence. These attenuators with switches attached are being manufactured by Daven Co.

Colvin pointed out that the requirement of injecting transcribed commercial announcements into programs on the air demands that turntables be modified to give the operator facilities for cueing and fader switching each machine. Turntable positions and switches must be arranged to allow the operator to manage with one hand. A number of expediencies may be necessary. For example, one modification combines the action of switch and fader in one movement. To put the turntable on the air, the ac switch is turned on with a forward motion of the hand which continues on to push open the fader.

He also discussed the important subject of suppressing playback noise on records and transcriptions. "The operation of this suppression is based, first of all, on the nature of playback noise and its relationship to the recorded program material. It has been found that the amplitude of the noise is approximately constant throughout a recording, irrespective of the amplitude of the recorded program. The noise is masked, but for moderate to low level passages, which constitutes a greater portion of an average recording, the noise may may become quite objectionable. Secondly, investigation reveals that the greater part of the noise energy lies in the middle and upper ranges of the audio spectrum. Very little noise is found below fifteen hundred cycles. The third

GE announcer's control unit for television operations to facilitate switching control circuits available to other locations in the studio. Right: Front view showing accessibility and general appearance of the new RCA 10kw FM transmitter





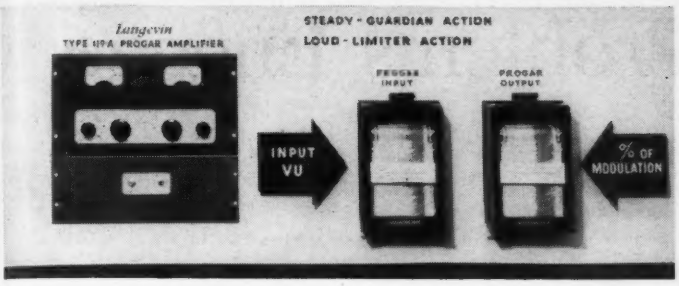
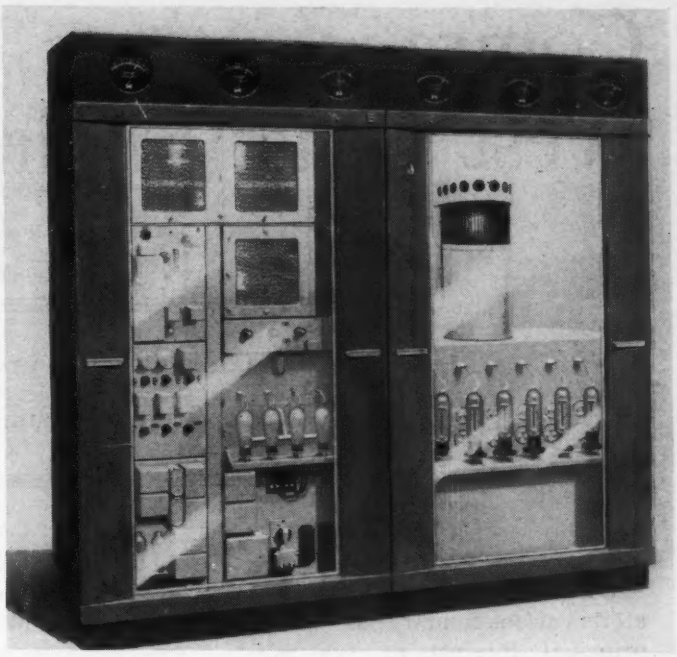


Exhibit showing graphically the operation of Langevin Progar amplifier



Newly styled Western Electric 3kw FM transmitter, one of a series from 1 to 50 kw power

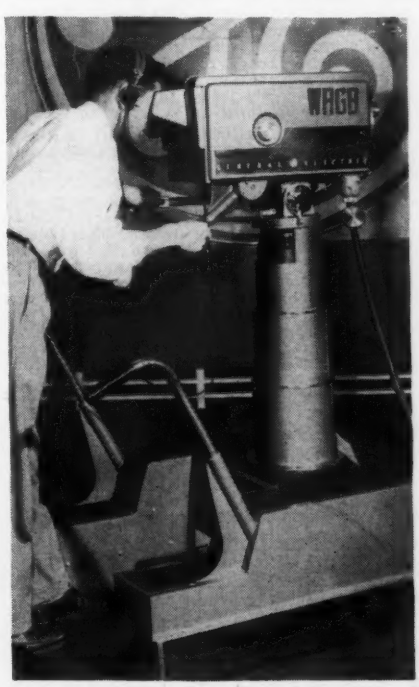
factor which enters into the design of this equipment is the relationship between the peak amplitude of the recorded program to the average amplitude of the noise. The program peaks are approximately 40 db . above the noise, and this figure was used for design purposes.

"With these facts concerning the nature and behavior of playback noise, an instrument was designed whose fundamental basis for operation was first set forth by Dr. Olson of the Radio Corp. of America's Princeton Laboratories, Dr. Olson's proposal and the final instrument evolved from it, centered around the characteristics of the germanium diode.

"In a conventional representation of input vs. output voltages for the germanium diode, little attention is given to the load line as it approaches very close to the origin. The load line for most practical purposes is linear. However, if the portion near the origin is enlarged it will be found that the load line does not remain linear, but curves tangentially to meet the ordinate axis. The point of tangency (approximately 1 millivolt input) determines the practical minium level at which conduction can occur in the forward direction. Therefore an effort to adjust the noise level of the recording so that it would fall in this clipping range was made. For reasons of design it was found more desirable to connect two diodes in series, doubling the clipping level and operating the networks at higher voltages. Two series diodes are connected back to back to form a full wave rectifier essentially linear except for very small voltages. With the noise level adjusted to fill the dead zone, the program material has a linear excursion some 40 db. higher in level.

"Although noise is rejected below the point of conduction, program material of a corresponding level is also rejected. This is not especially noticeable to the ear due to the wide dynamic range of most speech and music, except for some elimination of reverberation, or attenuation of sounds inherently low in amplitude such as the spoken letter 'S'."

Maintenance of transmitters and antenna systems was discussed by three speakers, evidence of its importance to broadcast operation. G. Porter Houston, chief engineer WCBM (Baltimore), emphasized the point that station operators need not be hired on the basis of trouble shooting ability. Trouble shooters can and should be trained. A systematic method based on logical analyses of circuits involved should replace the old trial and error systems.



GE's new light weight television camera which is pedestal mounted with all controls grouped at operator position

A. E. Towne of the Associated Broadcasters, Inc., continued on the subject of maintenance and suggested weekly, monthly and yearly maintenance schedules using carefully prepared printed forms.

With the number of stations using directional antennas continually on the increase, D. B. McKey, Consultant, sounded a warning that more attention should be given to the care and maintenance of directional antennas. In pursuance of this objective he suggests periodic reports as the basis for routine maintenance.

With technical regulation of as his theme, G. P. Adair, consultant, Washington, D. C., outlined a number of factors which should be considered when setting up broadcast standards. Some of these are:

(1) What ratio between desired and undesired signals is acceptable?
(2) To what percentage of listeners should this value be acceptable?
(3) What is a typical or adequate sampling group to determine this?
(4) What are the noise levels in various areas, which determine the minimum signal strength to be protected?
(5) What are the receiver selectivity characteristics to determine the adjacent channel ratios?
(6) Shall these be determined for the poorest receiver, the best or the average?

(*Continued on page* 103)

Communications Problems Engage West Coast Engineers

Television, FM and radio propagation subjects hold attention of 750 during five-day technical convention and an exhibition

• Communications engineering in all its various ramifications was the principal interest at the West Coast's most ambitious convention, held in San Francisco Sept. 24 to 28. The gathering was sponsored by two organizations, the Institute of Radio Engineers, which had charge of the technical papers for the convention, and the West Coast Electronic Manufacturers Association which staged an elaborate exhibition in the Whitcomb hotel. The technical sessions were held in the Palace hotel under the guidance of Stanford University's Karl Spangenberg, professor of electrical engineering.

The program was a complete and varied one including some 26 papers covering military applications, frequency modulation, industrial instrumentation, television, scientific electronic equipment, microwave matters and antennas. Included were inspection trips to the microwave and communications laboratories of Stanford, the cyclotron laboratories of University of California, as well as visits to Moffet Field and to the plants of Eitel-McCullough and the Hewlett-Packard Co. More than 750 engineers attended the gatherings.

Brief Synopses of Engineering Subjects Discussed by California Engineers

VHF BRIDGE FOR IMPEDANCE MEASUREMENTS, by Robert Soderman, General Radio Co., Cambridge, Mass.

This paper described a modified Schering bridge for the measurement of relatively small, high power-factor impedances in the range of 20 to 140 mc, with a resistance range of 0 to 200 ohms, and a reactance range of —200 to +200 ohms.

PULSE-COUNTER TYPE FM STATION MONITOR, David Packard and Norman Schrock, Hewlett-Packard Co., Palo Alto, Calif.

In a new type of FM station monitor in which measurement of the mean frequency of the swing is by means of a pulse-counter circuit. An IF frequency of 200 kc, obtained by beating the signal under test with a local oscillator, is amplified, limited and clipped giving a square wave FM output. The mean frequency is determined from the average length of the resultant pulses. A constant component of the 200 kc wave is subtracted thus providing a zero center deviation indication. This current is stabilized so that the zero deviation reading is substantially independent of line voltage changes, temperature changes and changes of tubes. A stability of one part in ten million is achieved over a period of 24 hours. The same pulse counter circuit is used as a discriminator and has excellent linearity coupled with extremely low hum and noise. Circuits are also provided for over-modulation alarm and for distortion and frequency response measurements.

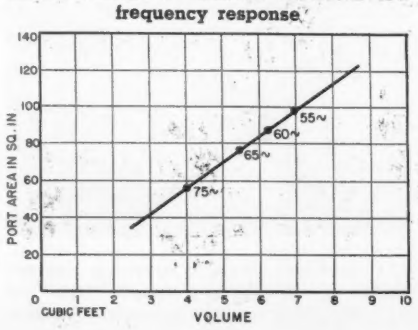
OSCILLATION AND GAIN PROPERTIES IN NEW TYPES OF TRAVELING WAVE TUBES, Lester M. Field, Stanford University, Calif.

Several new types of traveling wave structures operating in the S, X, and K bands were described and analyzed. These include a helix with a center conductor. One form, a concentric line with a loaded center conductor, shows great promise and is the basis of some 1.25 cm work. Electrons travel with about 0.1 the velocity of light. The helix with center conductor is found to propagate waves with velocities either greater or less than the "natural" velocity, depending upon the dimensions. The concentric line structure with the loaded center conductor tends to exhibit constant velocity as a function of frequency but at velocities corresponding to about one fifth the velocity of light.

NEW YORK-BOSTON RADIO RELAY, J. W. McRae, Bell Telephone Laboratories, New York.

The New York to Boston microwave relay system will consist of seven repeater stations spaced about 30 miles apart between the two terminals to operate in the 3700 to 4200 mc band and use square Barrow horn radiators with waveguide lenses in the mouths. In each repeater the signal frequency will be shifted 40 mc and gain will be provided in both the intermediate frequency of 65 mc and at the outgoing radio frequency. Magnetically focussed two resonator klystron amplifiers will be used, four such tubes giving a gain of 23 db with an output of ½ to 1 watt. Two two-way channels will be provided each about 10 mc wide, capable of accommodating several hundred telephone conversations or a television transmission in each direction. In either case a complete spare circuit will be available. Frequency modulation with a total deviation of 4 mc will be used for television.

Hilliard showed the area of the port of a base reflex speaker as a function of the cabinet volume to achieve indicated low frequency response



HIGH QUALITY LOUDSPEAKERS, John K. Hilliard, Altec Lansing Corp., Hollywood.

The characteristics of high quality loudspeakers designed to operate with maximum input powers varying from 15 to 1000 watts were described. Directional patterns for typical speakers operating at various frequencies were presented. Experiment with base reflex speakers shows that the ratio of port area to cabinet volume should be constant for various lower frequency limits with the volume inversely proportional to the low frequency limit desired.

NEW SOLUTION OF THE ANTENNA PROBLEM, Cornelius Lanczos, Physical Research Unit, Boeing Aircraft, Seattle.

The methods of analyzing antennas by means of the wave equation, transmission line theory, and integral equations were reviewed. A method of analysis was proposed which involves an integration of the effect of all the incremental lengths of an antenna.

EQUIVALENT NETWORKS FOR WAVEGUIDE PROBLEMS, John R. Whinnery, University of California, Berkeley, Calif.

Discontinuities in waveguides, such as steps, were analyzed. Such steps were shown to have an action equivalent to that of a lumped capacity located at the step. The magnitude of this capacity as a function of the step dimension was shown by curves. The analysis is based upon a resolution of wave components at the discontinuity in terms of all the higher order modes which can exist at the junction, and which com-

bine at that point to give the field its required form but which attenuate very rapidly away from the discontinuity.

PRINCIPLES OF RESNATRON DESIGN, W. W. Salisbury, Collins Radio, Cedar Rapids, Iowa.

This paper reviewed the operations of high power high voltage tetrodes which are capable of giving outputs of about 50 kw at 50 cm. Theory and practical aspects of the operation are discussed.

RADIO WAVE PROPAGATION IN THE FM BROADCAST BAND, by Kenneth A. Norton, Central Radio Propagation Lab., National Bureau of Standards, Washington, D. C.

The reasoning behind the ruling for shifting FM from 40 to 90 mc was stated. Greatly reduced sporadic long distance transmissions at the higher frequencies also were reported. Studies show that the power required to produce a given receiver output at a representative distance is minimum at about 90 mc. Atmospheric noise increases if the frequency is reduced whereas receiver sensitivity decreases if the frequency is increased. Propagation characteristics including tropospheric effects shows a sharp drop in signal strength at 75 miles for a 1000-foot transmitting antenna and at 25 miles for a 200-ft. transmitting antenna.

A STUDY IN PREDICTION OF TELEVISION GHOSTS CAUSED BY TALL BUILDINGS, Andrew Alford and G. J. Adams, Somerville, Mass.

The paper discussed the theory of ghosts produced by buildings. Buildings are found to have highly directive reflection characteristics. The method was applied to a hypothetical city.

MEASUREMENT OF THE Q OF RESONANT CAVITIES EXCITED THROUGH LINES AND COUPLING CIRCUITS OF APPRECIABLE LOSS, Louis Malter, Naval Research Laboratory, Washington, D. C.

The measurement of Q's or resonators when the coupling system has so much loss that the resonant impedance circle in the deflection plane is not tangent to the reactance circle was described, with charts and formulas so that the Q can be deduced immediately from data on the resonant impedance circle.

A FIVE KW TELEVISION BROADCAST TRANSMITTER, J. E. Keister, J. W. Downie, H. B. Sancher, L. M. Ewing, General Electric Co., Syracuse, New York.

A television transmitter covering the first 13 channels with a visual power output of 5 kw and a aural power output of 2.5 kw was described. Low level modulation, linear class B grounded grid RF amplifiers, and the method of amplifier alignment were discussed.

LIMITERS AND DISCRIMINATORS IN FM RECEIVERS, W. G. Tuller, MIT, Cambridge.

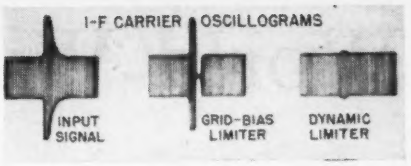
A new limiter-discriminator combination that is unusually free from impulse and common-channel interference was described. This is accomplished without the addition of extra tubes or circuit complications by the use of limiters which are lumped at the output of the amplifying stages. The discriminator used is the cathode-driven type which is less sensitive to impulse interference and more readily balanced than conventional units.

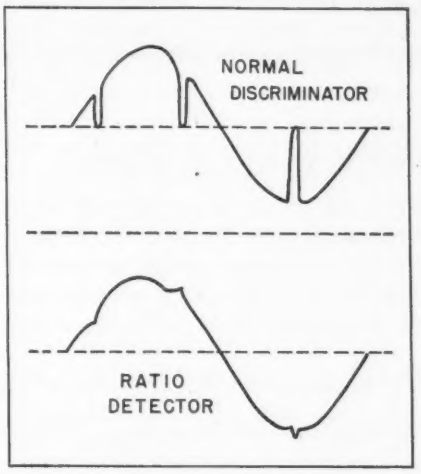
TECHNICAL PROBLEMS OF MILITARY RADIO COMMUNICATIONS, John Hessel, Signal Corps Engineering Labs., Fort Monmouth, N. J.

Major advances which are necessary to insure full utilization of radio in military communications of the future challenge the imagination of the engineering profession. The types of radio communications circuits and equipment which must be developed to satisfy planned military requirements were analyzed. Among other factors the inadequacy of the existing number of channels within the usable radio frequency spectrum was pointed out and the need for band saving devices such as single side band, etc., emphasized.

MICROWAVES IN ORDNANCE WORK, Frederick G. Suffield, Allison Associates, Los Angeles.

While the range of a projectile fired from a gun depends upon many factors, perhaps the most important is its velocity as it leaves the gun barrel. Portable field velocity measuring units (or field chronographs) were developed from various engineering approaches to the problem. One of the more successful methods utilized microwaves applying the Doppler frequency shift of a microwave signal reflected from the base of the projectile. As the velocity of the projectile falls off rapidly with increasing distance from the muzzle of the gun, it was necessary that the Doppler beat be measured in a very short time. The method used was the stopping and starting of counter circuits which were accurately controlled by a crystal oscillator. The number of audio cycles of the beat note received during a fixed interval of time directly indicates the projectile velocity.





Foster showed (above) effect of an impulse disturbance upon various portions of an FM receiver; (below) effect of impulse disturbance on receivers with two different kinds of detectors

TELEMETERING GUIDED MISSILE PERFORMANCE, James C. Coe, U. S. Naval Air Missile Test Center, Pt. Mugu, Calif.

Some methods used in obtaining and furnishing data on launching, altitude, acceleration, airspeed, ordnance, and propulsion of guided missiles in flight were described. Continuous wave carrier systems using either AM or FM with either AM or FM subcarriers are considered preferable to pulsed systems.

FREQUENCY MODULATION DETECTORS, S. W. Sealey, RCA Industrial Service Labs., New York.

This paper reviews the properties of the principle types of FM detectors. Of prime importance are the discriminator and the ratio detector. The latter is considered to be more stable and gives a wider range of linearity.

SUSCEPTIBILITY OF FM RECEIVERS TO INTERFERING SIGNALS, D. E. Foster, Hazeltine Research Inc. of Calif., Los Angeles.

The susceptibility of FM receivers to interference from other stations on the same or adjacent channels as well as image, combination beat, and multipath effects was reported with numerous curves resulting from tests of the various conditions.

APPLICATIONS OF ELECTRONICS TO UNDERWATER ORDNANCE, Ralph D. Bennett, Naval Ordnance Laboratory, Washington, D. C.

Of the several types of equipment described for measuring the characteristics an item of particular interest was a hydrophone which has a sensitivity of 10 dynes per CM^2 and a maximum usable pressure of 2500 dynes per CM^2. This hydrophone, used in a special bridge circuit, detects the behavior of underwater devices. A method of testing depth bombs by means of several of these hydrophones was described. Torpedo velocities are measured by lining up hydrophones along the path of the torpedo.

A 50,000 WATT FM TRANSMITTER FOR 100.5 MC.

High power at present FM frequencies is principally a matter of adequate vacuum tubes. The advantages of combining small vacuum tubes in a multi-unit assembly were evident in the experimental 50,000 watt KSBR transmitter where one tetrode stage and two grounded-grid triode stages, raises the power level from 50 to 50,000 watts. The power output efficiency is 62% in the last three stages, which are operated from a common 4000 volt source.

DETERMINATION OF MUTUAL IMPEDANCE OF ANTENNAS by Dr. F. R. Abbott, Naval Electronics Lab., San Diego.

An experimental set-up was described whereby mutual impedance of antennas and the patterns of arrays can be measured. Mutual impedance is determined by measurements on the input impedance of an antenna, when an adjacent is first opened and then shorted. Antenna patterns were presented which were directly observed on a model operating at about 12 centimeters. Tests were made on odd shapes of antennas such as cones as well as cylinders. Tests with cones showed that parasitic cones are effective only when the slant height is in the vicinity of resonance.

N.Y.-Schenectady TV Relay Opened

General Electric Co., on Monday Sept. 29 officially placed in operation its new microwave television relay system linking New York with its television transmitter WRGB in Schenectady. The link is to be used to pick up programs broadcast by any of the three New York TV stations now operating for rebroadcast in the Schenectady-Albany area. On occasion programs broadcast by Philco's WPTZ in Philadelphia, beamed to New York, also will be transmitted over the link as will programs originating in NBC's Washington outlet.

The relay, which operates in the 2000 mc region, consists of two unattended receiver-transmitter stations, the first located at Beason, N. Y., approximately 55 miles from the originating microwave transmitter atop the GE building in New York, and a second 55 miles further north at Round Top mountain. The program goes thence to a receiving station atop the Helderberg mountains where WRGB transmitter is located but is not put directly into the transmitter at that point. Instead it is beamed into Schenectady, a distance of about 22 miles, where it is received on equipment in the WRGB studio building so that it may be coordinated with locally originated programs. It is then sent by microwave beam to the main transmitter on the mountain. There are no wire links.

(*Continued on page* 94)

Survey of World-Wide Reading

Electronic news in the world's press. Review of engineering, scientific and industrial journals, here and abroad

Testing Network Performance with Exponential Signals

D. K. C. MacDonald (Philosophical Magazine, London, England, November, 1946, pp. 778-789)

The two conventional methods of specifying the performance of linear networks by noting their response to sinusoidal voltages as a function of frequency or their response to a unity step function as a function of time are reviewed and their mathematical relations are discussed.

A method is suggested involving the characterization of networks by their response to exponential current or voltage pulses of the forms ($e^{-\alpha t}$) and ($1 - e^{-\alpha t}$) for positive values of time; the signal generator time constant, α, is adjustable. These four pulse types can be readily generated by standard procedures.

The exponential admittance (output current corresponding to an applied exponential voltage) and the exponential impedance (output voltage corresponding to an applied exponential current) for a resistor, a capacitor and an inductance are computed and illustrated; they are readily attributed to the particular element.

For an input voltage proportional to $e^{-\alpha t}$, a combination of a resistor and an inductance in parallel with $R/L = \alpha$, provides a constant exponential admittance equal to $1/R$.

Similarly, the series combination of a resistor and an inductance and the series and parallel combinations of a resistor and a capacitor each have a constant output for another of the three remaining basic input waves and for the correct time constant.

While transients or decreasing terms appear in the expressions for the response of other input-network combinations or for time constants not adjusted to the required value, these also may contribute to the testing of network performance.—JZ

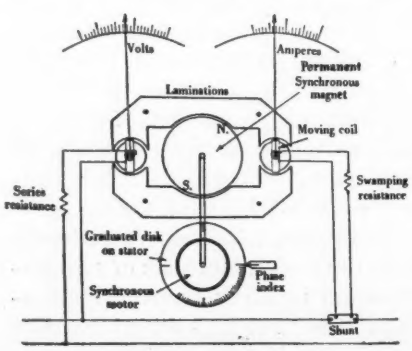
Polar Ammeter

E. B. Brown Journal of Scientific Instruments, London, England, August, 1947, pp. 197-198)

The instrument measures small ac voltages and currents and also indicates the phase. Two moving coil systems, one for current and one for voltage measurements, are mounted in laminated field poles. The field poles are supplied with a synchronous alternating flux by a two-pole permanent magnet rotated by a small synchronous motor driven by the same supply which provides the current to be measured. The stator of this motor can be rotated independently to adjust the phase of the flux and this phase can be read on a scale attached to the motor.

For current measurements, the stator is rotated until maximum pointer deflection is obtained. Pointer deflection will then be proportional to the rms value of the current, and the scale may be calibrated linearly. Voltage measurements are similarly carried out.

Polar ammeter indicates small ac currents and voltages as well as their phase



If a complex wave form is applied to the instrument, only the fundamental component will contribute to the pointer movement.

Accurate phase indications are secured by rotating the stator about 90 deg. from this maximum position until the pointer reading is zero. The phase of the flux is then exactly in quadrature with the current, while the maximum in-phase adjustment is not sharp.—JZ

Synchrodyne Receivers

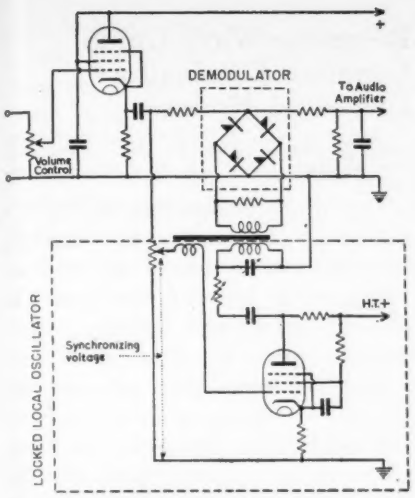
D. G. Tucker (Electronic Engineering, London, England, March 1947, pp. 75-76, August 1947, pp. 241-245, and September 1947, pp. 276-277)

The synchrodyne receiver demodulates the incoming AM-rf signal by multiplying it with a local oscillation of carrier frequency. This demodulation may be accomplished in a ring demodulator or in a Cowein demodulator circuit. The carrier frequency signal voltage is obtained by locking an oscillator, tuned close to the carrier frequency, with the signal. By tuning the oscillator close to a desired carrier frequency, a broadcast station can be selected.

Careful studies of the behavior of locked oscillators preceded this design.* It can be shown that the non-linearity of the oscillator as well as its frequency selectivity tend to select the desired carrier voltage and to discriminate against unwanted carriers and against the modulation sidebands.

In this type of receiver, selectivity is determined by the oscillator characteristics and operating conditions, while the transmitted audio bandwidth depends on the properties of the main signal path. Selectivity and quality of the receiver are therefore independent

*See "Non-linear regenerative circuits", Wireless Engineer, June 1947, by the same author.



In the synchrodyne receiver a local oscillator is tuned to the frequency of the desired broadcast station and the incoming signal demodulated by means of the locally generated signal

of one another and quality reception is consistent with high discrimination. AVC voltage is supplied by the dc component of the demodulator, as this component has an amplitude proportional to that of the input carrier signal.—JZ

The German Use of Sonic Listening

L. E. Holt (Journal of the Acoustical Society of America, July, 1947, pp. 678-681)

In Germany sonic listening devices were developed while these devices were abandoned by the U. S. Navy between the wars and replaced by ultrasonic equipment. It appears that the Germans adapted the ship structure to meet the acoustical requirements. Different German hydrophone arrays for various types of ships are described and their efficiency stated.—JZ

Radio Noise Originating in the Ocean

Y. Rocard (Académie des Sciences, Comptes Rendus, Paris, France, July 7, 1947, pp. 50-51)

The salt water of the ocean being a conductor, the sinusoidal waves may be considered as conductors moving in the magnetic field of the earth. The field component at right angles to the displacement of the water will induce an alternating electromotive force which is responsible for an alternating current through the water. This current in turn generates a varying magnetic field.

An electromotive force induced in the antenna of a receiver would be proportional to the time derivative of this magnetic field. Approximate computation and assuming a frequency bandwidth Δf, the time derivative of the magnetic field will be equal to $1.2 \times 10^{-4} (\Delta f)^{1/2}$ gauss per second for an agitated ocean.—JZ

Simple Method for Measuring Permeability of Powder-Cored Coils

R. Schiffermueller (Elektrotechnik und Maschinenbau, Berlin, Germany, Vol. 63, Nos. 11-12, pp. 254-256)

To determine the permeability of powder-cored coils, the stray field of a current-carrying coil is shielded by the powdered core to be investigated. The current induced in two coils arranged outside the shielding core is a measure of the permeability of the core.—JZ

Infinite Rejection Filters

A. M. Stone and J. L. Lawson (Journal of Applied Physics, August 1947, pp. 691-703)

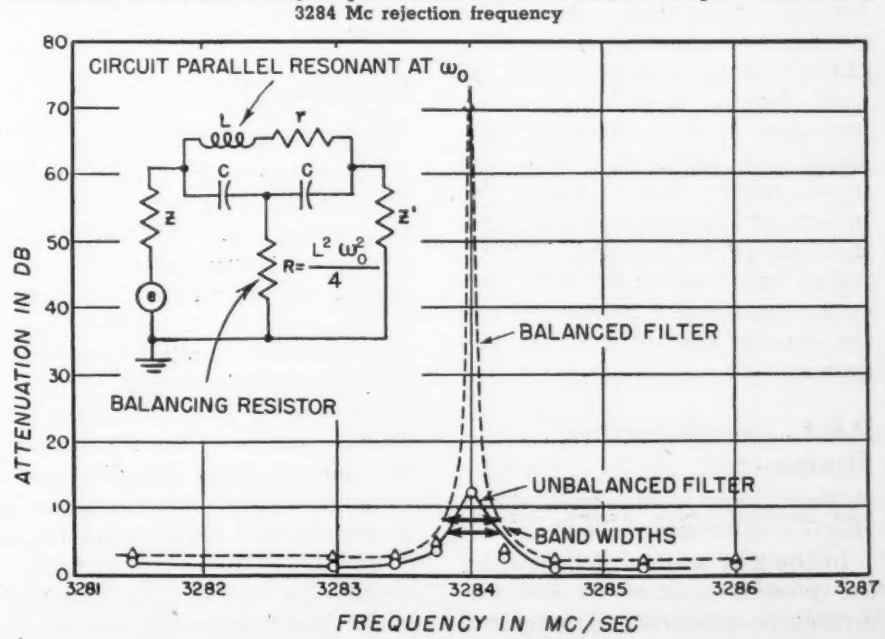
The rejection properties of bridged-T networks are studied. When balanced, i.e., when a resistor R of suitable value is inserted as illustrated in inset drawing, infinite attenuation at the resonant frequency ω_0 of the parallel LC circuit can be assured, while the narrow bandwidth of the uncompensated filter is retained. Alternatively the coil may be tapped, the two circuits having identical frequency response curves.

In the analysis, the bridged-T network is developed into the symmetrical lattice form, this equivalent circuit considered as a four-arm bridge, and the condition for zero output derived.

It is intended to eliminate cw or low-frequency modulated carrier interference from a 10-cm radar system. The theory is therefore extended to ultra-high frequency circuits. Several possible methods for obtaining infinite-rejection uhf filters are discussed, and some experimentally obtained results are presented. Structures equivalent to a balanced bridged-T network using high-Q cavities as resonant circuit and waveguides as balancing resistor were built. In one instance (see curves in figure), a 3000 mc center frequency is attenuated by 70 db and the bandwidth, measured between the points where the power transmitted is 3 db below the off-resonance value, is equal to 0.5 mc. The second curve corresponds to a value of the balancing resistor R considerably different from the compensating value.

The distortion due to this type of filter of a rectangular high frequency pulse, for instance a radar signal, is investigated. If the carrier frequency of the signal is distant enough from the rejection frequency ω_0, the pulse will pass unaffected. For carrier frequencies equal to the center frequency, however, the pulse will be badly distorted, though not eliminated, because of its content in other frequencies.—JZ

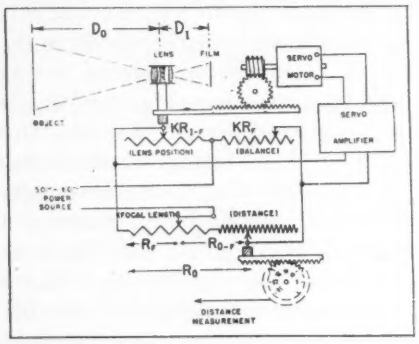
Attenuation as function of frequency of balanced and unbalanced bridged-T networks at 3284 Mc rejection frequency



Remote Focusing Control Of Lenses

H. C. Silent (Journal of the Society of Motion Picture Engineers, August 1947, pp. 130-139)

Apparatus is described to be used with advantage in television or motion picture cameras for focusing the lens. The lens must be moved so that for any lens-to-object distance, D_o, and any lens-to-image distance, D_I, $(D_o-F)/F = F/(D_I-F)$, where F is the focal length of the lens. In many instances, the lens is moved in accordance with a scale calibrated



Wheatstone bridge output operates servo motor which automatically focuses lens

for the particular lens or by means of a cam cut for the lens.

The present automatic lens focusing device is based on the similarity between the above expression and the balance requirement of a Wheatstone bridge. Consequently, if the resistors in the bridge arms are arranged as shown in the figure and have values proportional to the numerators and denominators in the above equation, the bridge will be balanced for the correct lens position. The resistor R_{O-F}, corresponding to the object-to-lens distance minus the focal length, is adjusted either manually or by a distance indicator; the servo amplifier and servo motor then balance the bridge and simultaneously move the lens in its focusing position. Initial adjustments for each lens of the focal length resistor R_F and the balance resistor KR_F are necessary.—JZ

B.B.C. Disc Recording Equipment

H. Davies (Journal of the Institution of Electrical Engineers, London, England, Part III, July, 1947, pp. 275-300)

In the first section of the paper, the present practice of disc recording is reviewed and compared with other recording methods. Standard disc sizes and turntable speeds and resulting cutting speeds as well as groove dimensions and spacing are investigated as to their effects on fidelity and signal-to-noise ratio. Radius compensation to improve the high frequency response at the inside of the disc is discussed. The recording characteristics of the B.B.C. and N.A.B. are compared.

In the second section, a few selected technical problems and their solution as exemplified by the B.B.C. equipment are presented. The turntable drive, the cutter head and its mounting, the method of placing cue-marks on the discs, swarf removal, and the arrangement of the radius compensation circuit are the points given particular attention. Further details of the equipment designed for the B.B.C. studios are given in a third section.—JZ

The Betatron at Melbourne

W. B. Lasich and L. Riddiford (Journal of Scientific Instruments, London, England, July, 1947, pp. 177-179)

The operation and construction of a 2.8 MeV Betatron, built at the University of Melbourne, Australia, is described. Details of the magnet and the doughnut incorporated in this small laboratory model are given. The X-ray output of the apparatus is equal to 0.015 roentgen/min. at a distance of 1 meter. The energy intensity distribution of the X-rays was also measured. It was found to be continuous with a maximum intensity at 1 MeV.—JZ

Extending FM Coverage

(G.E.C. Journal, London, England, February, 1947, pp. 144-166)

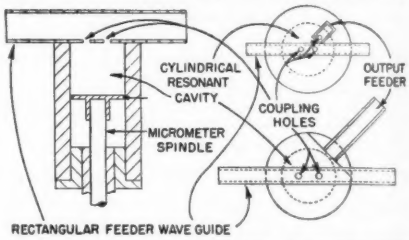
Experiments by the General Electric Co. of England in connection with a method to increase the area covered by an FM uhf station are discussed. One transmitter covering a circular area was used and another directional transmitter operating at a different frequency was stationed in the vicinity of the first transmitter. The signals from the directional transmitter were received in a station located outside the range of the first transmitter, and reradiated on the same carrier frequency as the first signal.—JZ

Resonator-Wave Guide Coupling Eliminates Undesired Modes

B. Bleaney, J. H. N. Loubser and R. P. Penrose (Proceedings of the Physical Society, London, England, Vol. V/59, Pt. 2, No. 332, pp. 185-199)

For the investigation of the dielectric properties of liquids, wavemeters, accurate to one or two parts in ten thousand and operating in the one to four centimeter region, were required.

The H_o mode was selected for its low dissipation of energy in the walls of a resonator, because there is no current flow in the radial direction on the end walls of the guide—the cavity may therefore be tuned by a non-contact



Feeder and output coupling for wavemeter are coupled to resonant cavity in such a manner that undesired modes are suppressed

piston without leakage of energy past the piston—and because it is a single mode, it is stable against small irregularities of the guide.

For an accuracy of one or two parts in ten thousand and a resonator diameter of 19 mm, corresponding to a wavelength of 1¼ cm, the allowable error in the diameter is only 0.003 mm. If the resonator diameter is increased to 30 mm, the machining tolerance becomes 0.012 mm. This diameter, however, would permit the propagation of 16 different modes for a 1¼ cm wave and the elimination of undesired modes becomes imperative. Coupling arrangements from the feeder waveguide to the cylindrical resonator containing the substance to be studied and from the resonator to the detector unit were designed to couple the H_o mode to the exclusion of any other mode liable to be present.

To prevent the propagation of undesired modes, the feeder resonator coupling is constructed so that only one field component, exciting preferably only the desired mode in the resonator, is present. On the narrow side wall of a rectangular H_1 waveguide, only the

longitudinal magnetic field component is different from zero, so that only modes having a magnetic field component in that direction will be coupled into a resonator fed from that wall. If, therefore, the side wall of a rectangular guide is coupled to the end wall of a cylindrical resonator along an axial plane (left figure), only a radial magnetic field will be transferred to the cavity. The E_0 wave, which has no radial magnetic component at the end wall of the cylindrical cavity, will be eliminated.

Further by coupling through two equal, symmetrically arranged holes spaced half a wavelength apart in the rectangular waveguide and placed at diametrically opposite points in the cylindrical cavity, odd order modes will be suppressed. The two holes tend to set up these modes with a 180 deg. phase shift and they therefore cancel out.

The fields of higher order modes, possible in large diameter cavities, are concentrated towards the periphery and are relatively weak near the axis, so that in a large diameter cavity the coupling to these modes is small because the distance of the input coupling holes from the axis of the cavity is only a small fraction of the cavity radius.

The output coupling, (lower right), consists of a single hole in the side of the resonator located one quarter wavelength from the end wall; it feeds into a rectangular waveguide and the plane containing the magnetic field in the guide passes through the axis of the cylindrical cavity. The output guide then couples to the axial magnetic field component in the cavity. As this field is zero for the H_2 mode at an angle of 45 deg. to the input guide, this mode can be eliminated in the output coupling. Further, if the output guide is oriented at this angle, it will not couple to any E-waves, since these have no longitudinal magnetic field component.

In an alternative arrangement, the output coupling was placed on the end wall of the cavity, again at 45 deg. to the input, (upper right). The output hole is located at a distance from the axis equal to 0.55 times the radius of the cavity, where the radial overtone of the desired mode has zero radial magnetic field.

A wavemeter fed in this manner, and with a cavity diameter of 3.0 cm has been constructed from copper for wavelengths ranging from 1.15 to 1.55 cm. An accuracy of 2 parts in 10,000 in the wavelength and of 0.02% in the dielectric constant is indicated by measurements. A resonator 5.075 cm in diameter for 3.2 cm waves with side wall output coupling and a resonator 2.106 cm in diameter for 1.35 cm waves with the detector coupled to the end wall have also been constructed. All dimensions were accurate to one thousandth of a centimeter.

Dielectric constant, temperature coefficient of dielectric constant, and power factor of six non-polar liquids have been studied with these cavities and the results are reported.—JZ

Measuring Dielectric Properties at 10,000 Mc

T. W. Darkin and C. N. Works (Journal of Applied Physics, September, 1947, pp. 789-790)

Dielectric constant, ϵ, and tangents of the dielectric loss angle, tan δ, have been measured for several plastic and ceramic materials at a wavelength of 3 cm. The results are presented in the accompanying table.

A slab of the dielectric material is placed against the reflecting termination of a waveguide, and the position and width of the minima in front of the sample are determined by a slidable probe. Formulas for the computations valid for materials having a dissipation factor less than 0.1 are derived. Experimental equipment and evaluation of probable errors are discussed.—JZ

Dielectric properties at 3-cm

Material	ϵ	tanδ
Polyethylene	2.29	.00032
Polystyrene	2.43	.00036
Teflon	2.05	.00025
Insanol*	7.96	.0042
Corning glass 704	4.79	0.0063
Corning glass 707	4.05	0.0022
Micarta 254†	3.36	0.039
Micarta 299†	4.61	0.0211
Micarta 259†	5.36	0.041
Cerex resin	2.69	0.0031
Polydichlorstyrene	2.63	0.0005
Nylon	3.09	0.0106
993 Silicone	2.90	0.0050
Fosterite 80-20	2.57	0.0048
Fosterite 35-65	2.58	0.0144
Molded Micarta 192a	4.34	0.0093
Kraft board, dry	2.99	.05
Dense Kraft board, dry	3.20	.05
Ivory, walrus tusk	6.98	.0934

* Westinghouse product similar to Mycalex.

Micarta 259 is a glass cloth melamine formaldehyde resin laminate. Micarta 254 is a Kraft paper cresol formaldehyde resin laminate. Micarta 299 is a glass cloth cresol formaldehyde resin laminate.

Synchronization of Relativistic Resonance Accelerators

M. Rabinovich (Journal of Physics, Moscow, Russia, Vol. X, No. 6, pp. 523-532)

Two possible adaptations of the cyclotron for the acceleration of high energy particles consist in either increasing the magnetic field during the stay of the particle in the apparatus (synchrotron) or in varying the frequency of the electric field. These expedients assure that the particle, though its mass increases with an increase in its velocity, reaches the accelerating gaps at the desired instants. The phasing properties of these two accelerators are studied and their stability of operation is investigated.—JZ

Properties of Barium Titanate

M. G. Harwood, P. Popper, D. F. Rushman, and H. F. Kay, R. G. Rhodes, and J. K. Hulm, three separate articles (Nature, London, England, Vol. 160, pp. 58-59, 126-128, 1947)

It is established that the transition temperatures, about 125°C, between the ferroelectric and the non-ferroelectric phase structures of barium metatitanate, or its Curie point, which is characterised by a peak in the dielectric constant-temperature curve, is identical with the transition from a tetragonal to a cubic crystal structure. It appears that the transition from one crystal structure to the other is gradual and extends over a temperature range of several degrees C where both phases coexist. By rapid cooling or heating, instantaneous higher values of the dielectric constant than those normally observed may be obtained.

The second article reports the artificial growing of 2 mm crystals. These crystals are piezoelectric at room temperature. A study of the dielectric properties of single barium titanate crystals is reported in the third article.—JZ

WASHINGTON

★ ★ ★ **Latest Electronic News Developments Summarized by Tele-Tech's Washington Bureau** ★ ★ ★

BATTLE ROYAL ON ELIMINATION OF TV CHANNEL 1—A battle royal between Television, FM and broadcasting companies and organizations and telephone companies, police-fire-bus-truck-taxicab-highway groups, railroads and mobile radio manufacturers looms in the Commission oral argument on Nov. 17 over the FCC's proposed elimination of television channel 1 and barring of sharing television channels except in sparsely-settled areas of the country. Because of the strong protests by the television interests, FCC may find possible solution in granting 12 channels on an exclusive-use basis with complete elimination of sharing by other services. This thought was expressed by Philco and RCA and NBC also were inclined to the ending of sharing arrangements. But these companies and the Television Broadcasters Association and National Association of Broadcasters are planning to voice extremely strong contentions that space in the spectrum is already too scarce for television and instead of eliminating channels more space should be provided. FM broadcasters, Inventor Armstrong and Zenith also are slated to censure the FCC reallocation proposal as harmful to FM broadcasting progress. The mobile services are countering that their operations have a public importance and safety aspects and the number of frequencies available now are far too limited.

SEE DIVISIONAL SET-UP COMING — Because of the complexities of present-day communications and radio requiring specialization in blueprinting policies, the Commission may soon turn to the divisional setup. This would mean the breaking down of the FCC operations into three divisions—Broadcasting (including AM, FM and Television); Common Carrier (Telephone and Telegraph both domestic and international); and Safety Services (Aviation, Marine, Mobile with the latter including public mobile radiotelephone, fire, police, highway maintenance). Under the divisional structure four Commissioners would serve on a division, including the FCC Chairman as an ex-officio member, while broad policies involving different services and frequency allocation matters would be delineated by the en banc or entire Commission.

TELECOMMUNICATIONS CONFERENCE TO CARRY ON—Even though the International Telecommunications and Radio Conferences concluded a masterful job of accomplishment at Atlantic City during the past 4½ months, the task still has to be carried on. Key American governmenal officials have been designated to complete the tasks set up at the Conferences—the preparation of the World Frequency List through the Provisional Frequency Board and the newly created International Frequency Registration Board which will in the future register and determine frequency assignments to avoid interference and to permit the greatest utilization of the spectrum, and the Administrative Council of the International Telecommunications Union which will hold periodic meetings to determine questions of policy for the radio and telecommunications organizations of the world. Representing the United States on the International Frequency Registration Board and elected the Board's Chairman is Captain Paul D. Miles, now chief of the FCC Frequency Allocations Division who had a distinguished career as the Navy Department's leading frequency expert during the war and before that as a radio engineer in communications and broadcasting.

MOBILE RADIO HEARING AGAIN POSTPONED—For the third time, FCC has postponed its hearing on the general mobile radiotelephone services which is viewed as giving the foundation for frequency assignment, licensing and regulatory policy-making. Due to crush of broadcasting and FM and television cases and problems and length of International Telecommunications Conference, the Commission has shelved original hearing date of latter part of September back to Oct. 27 and now has slated the proceedings to start Dec. 8.

MISCELLANY—Willett Co., large Chicago truck and bus company, using Raytheon equipment, reported to FCC savings in vehicular operations and 99% reliability in radio service . . . State highway departments plan large program of equipping maintenance vehicles, bulldozers, etc., with radio . . . Radio Technical Commission for Aeronautics now has been designated as government agency, instead of Civil Aeronautics Administration, to formulate radio equipment standards for cargo and passenger aircraft; CAA then to distribute technical standards orders among radio manufacturers, eliminating necessity of prior certification of equipment by CAA.

ROLAND C. DAVIES
Washington Editor

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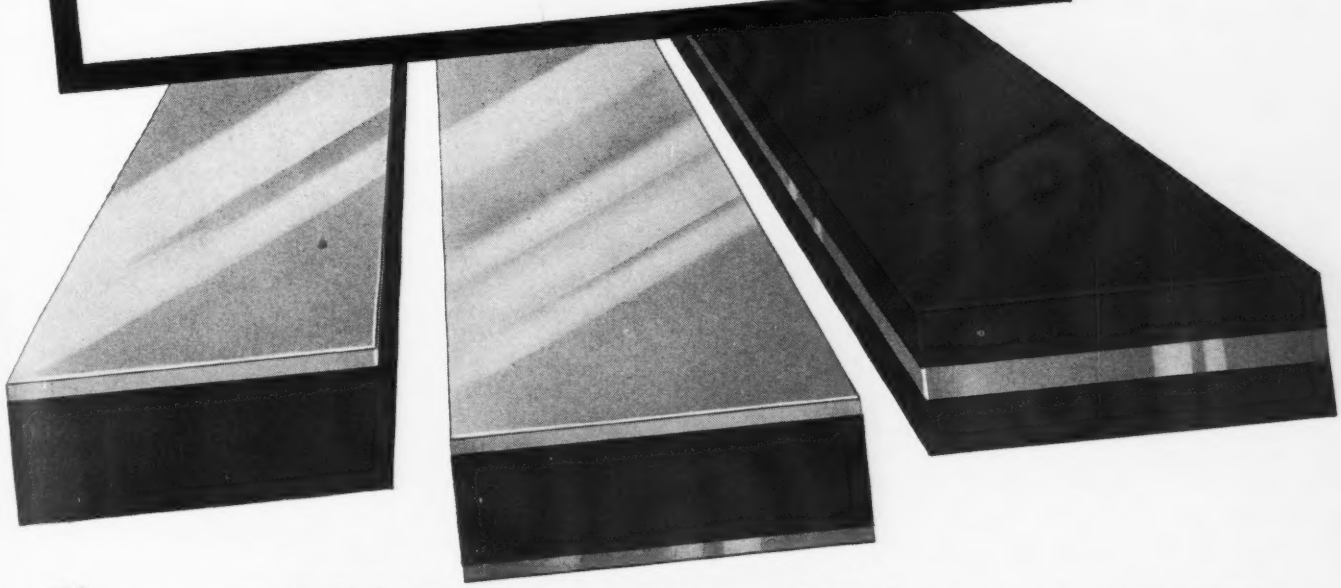

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News of the Industry

Set Allocation Dates

Effective date for putting into force the new table of international frequency allocations (Tele-Tech for Oct., page 29) have been tentatively established. The committee that has such things in charge has agreed to recommend that the frequencies above 27.5 mc go into effect Jan. 1, 1949, with those below 27.5 mc going into force at the effective date of the new International Frequency List, which probably won't be until some time in 1949.

Transportation Companies Want Relay Service

Another message relay type radiophone service, this time for the use of bus and truck operators, has been set up. Mobile Radio Telephone Co. has applied to FCC for authority to construct land stations in ten cities in five states with initial installations for mobile equipment in 500 vehicles. Head of the organization is Robert J. Phillips of the Chicago investment firm of that name; associated with him are Frank J. Walker, chief engineer of National Bus Communications, Inc. and Eugene S. Goebel (Motorola). The company plans to provide message relay service with no direct connection between the mobile system and the telephone lines.

Highway Engineers Plan Radio System

American Association of State Highway Engineers is considering use by members of their own radiophone equipment. A five-member technical committee has been set up to consider relative costs between common carrier methods and a states owned system. H. A. Radzikowski, chief of the bureau of public roads maintenance division, is secretary of the committee which also will suggest equipment specifications and geographical allocations of frequencies for the service.

W2XJT-TV Now Operating

The New York area has another television transmitter in operation on an experimental basis. W2XJT, owned and operated by William B. Still is operating on channel 13 Tuesday, Thursday and Saturday evenings between 8 and 8:30. Station is located in Jamaica, Long Island, plans soon to start daytime schedules.

TV for Venezuela?

Venezuela may soon have a television broadcaster. It is reported that American technicians, backed by American money, are now negotiating for construction of a station in Maracaibo.

RAILROAD RADIO

Arrangement of the Western Electric radio equipment in the General Motors "Train of Tomorrow", permitting passengers to call anywhere while train is en route

British to Expand Television Coverage

Television is going ahead rapidly in England. British Broadcasting Corporation, post-office monopoly, plans expansion to cover all populous centers, first attempt to be a relay between London's Alexandria Palace transmitter, only one in the British Isles, and Birmingham. BBC operates on the Marconi-EMI system, with a 405-line picture. At present there are approximately 12 manufacturers producing TV sets which sell for from $200 to $500. Until the recent fuel shortage about 2,400 sets were made weekly. Total sets in use as revealed by license ($8) statistics was 21,300 in June of this year.

Cliff Dwellers TV Solved

Television Broadcasters Assn., Inc., believes the apartment house television antenna problem has been solved. At any rate, it has dissolved its sub-committee, formed for the purpose of finding a solution to the problem when New York apartment house owners last February banned TV antennas on their buildings. Two master antenna systems, now available, have made further solution finding unnecessary.

Citizens Mobile Service

Extending the usefulness of mobile radiophone equipment, a group of business and professional people in Freeport, (Long Island) N. Y., is to institute a "Telephone Answering Exchange" in conjunction with mobile transmitting and receiving equipment to be installed in the vehicles of subscribers to the service. The answering exchange will receive messages from radio equipped cars for relay over the land lines. Similarly, the exchange will be able to reach subscribers' vehicles through a selective calling system. The service will be operated by Freeport Community Radio Association of which John A. Shell, M.D. is president, Lester A. Wood, owner of a shipbuilding construction firm is vice-president and secretary, and supervising manager is Maurice D. Holland, head of the radio marine sales and service organization bearing his name. Twenty-four hour service will be given with a central FM transmitter operating in the 152.03-157.29 mc band. Subscribers will pay approximately $10 a month.

NBC Shakes Up Engineering Personnel

A number of changes in the executive staff of the National Broadcasting Co. have been made to facilitate expansion plans in the television field. Vice-president John F. Royal has been made assistant to executive vice-president Frank E. Mullen. Personnel of the television department will report to Noran E. Kersta, who works directly under Mullen. To permit vice-president and chief engineer O. B. Hanson to devote most of his time to TV, George McElrath has been appointed director of engineering operations. He will assume responsibility for management and the operation of the technical aspects of sound broadcasting. Charles P. Hammond has been made assistant to the executive vice-president. James H. Nelson has become director of advertising and promotion. Robert E. Shelby, formerly director of technical development, has been appointed to the new post of director of television engineering operations. His place is to be taken by George M. Nixon, formerly assistant director.

CONVENTIONS AND MEETINGS AHEAD

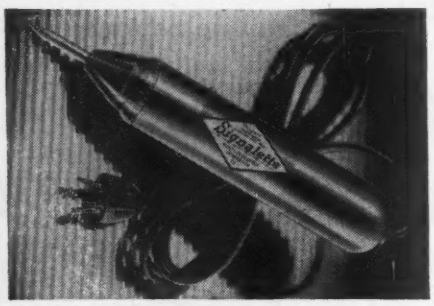
November 3-5—National Electronics Conference. Edgewater Beach Hotel, Chicago.

Nov. 17, 18, 19—Rochester Fall Meeting, RMA Engineering Dept. and IRE, Hotel Sheraton. Virgil M. Graham, Chairman, Sylvania Electric Products, 40-42 Lawrence street, Flushing, N. Y.

March 22-25—IRE convention and Radio Engineering show, Grand Central Palace and Hotel Commodore, New York.

May 10-15—Radio Parts and Electronic Equipment Shows, Inc., Hotel Stevens, Chicago.

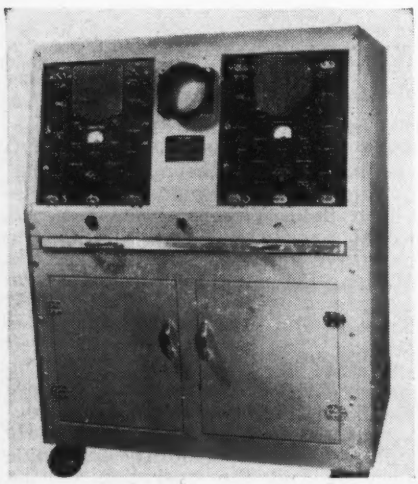
New Lab and Test Equipment



Pocket Signal Generator

(Use Inquiry Card, Mentioning No. 1101)

The "Signalette" pocket-size signal generator, consisting essentially of a multivibrator, produces rf, IF, and AF frequencies simultaneously from approximately 2500 cycles through 20 mc. Operating on either 110 V ac or dc, the generator has a fundamental frequency of approximately 2500 cycles, modulated by the 60 cycle supply, when used on the ac line. Successive harmonics are separated by 2.5 kc and tend to blend together in the test speaker into a continuous, easily identified tone. Approximately 9¼ in. long and 1½ in. in diameter, the unit weighs only 9 oz. It has an adjustable output attenuator and is completely isolated from the power source.—**Clippard Instrument Laboratory, Inc., 1125-33 Bank St., Cincinnati, Ohio.**



Dual Channel Oscilloscope

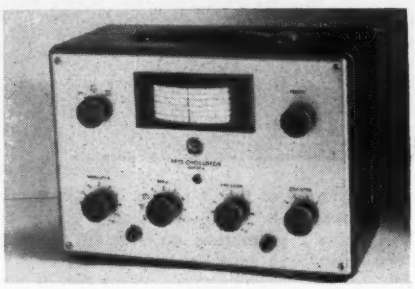
(Use Inquiry Card, Mentioning No. 1102)

Designed particularly for applications in the high frequency region, model E-2G15 dual channel oscilloscope comprises two separate channels operating into a type 5Z2P dual gun cathode ray tube, which is available in any of the standard phosophors. For photographic applications the instrument can be supplied equipped with General Radio Type 651-AE oscillograph recorder. Switches are provided to permit independent operation of the X-axis, sweep, and grid modulation functions, or common operation of the two channels. Separate external connections may be made to the 8 deflection plates and 2 second anodes. A sawtooth time base with a frequency range from 5 cps to 500 kc is provided, as well as a triggered sweep for the study of transients, having writing rates of 0.2, 0.5, 1, 5, 20 and 200 microseconds per inch. Internal blanking of the trace is provided. Vertical amplifiers for each channel have a uniform frequency response within ± 10% from 20 cycles to 4 mc, while the response of the horizontal amplifiers is uniform within ± 10% from 5 cycles to 1 mc. The instrument operates on 115 V, 60 cycles.—**Electronic Tube Corp., 1200 East Mermaid Ave., Philadelphia 18, Pa.**

Audio Frequency Meter

(Use Inquiry Card, Mentioning No. 1103)

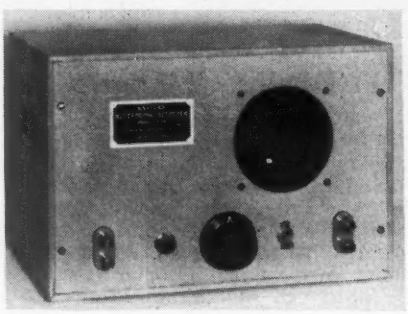
Model 300 audio frequency meter permits direct measurement of audio frequencies up to 30,000 cycles in six ranges from 0 to 100; 300; 1,000; 3,000; 10,000; and 30,000 cycles. The circuit consists of an input voltage amplifier followed by two limiting amplifiers, an RC integrating circuit and a full-wave rectifier, the dc output of which is a linear function of frequency. Sensitivity is a minimum of .5 V input. It will operate on any wave form with peak ratios of less than 8 to 1. A 3-in. fan type meter with two scales provides easy visibility. The instrument operates on 110 V, 60 cycle. —**Barker & Williamson, Inc., 237 Fairfield Ave., Upper Darby, Pa.**



Test Oscillator

(Use Inquiry Card, Mentioning No. 1104)

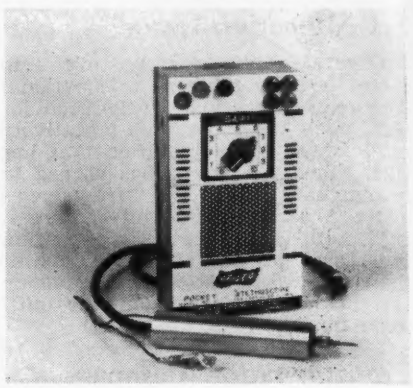
Providing three fixed frequencies of 455 kc, 600 kc and 1500 kc for high speed alignment of radio receivers, RCA type WR-67A test oscillator contains a compensated Hartley-type oscillator which maintains stable operation over the frequency range of 100 kc to 30 mc. An internal 400-cycle modulation source is adjustable up to 50%, and a jack is provided for external amplitude modulation. Four-step attenuator levels, in addition to fine adjustment, provide continuous control of rf output from 4 microvolts to one volt without necessity of changing leads. RF leakage through the ac line and through the case is reduced by a line filter and dual shielding. A signal injection probe simplifies application of tests signals to any part of the receiver without use of clip connections. The unit utilizes miniature tubes.—**Radio Corp. of America, RCA Victor Div., Camden, N. J.**



Frequency Meter

(Use Inquiry Card, Mentioning No. 1105)

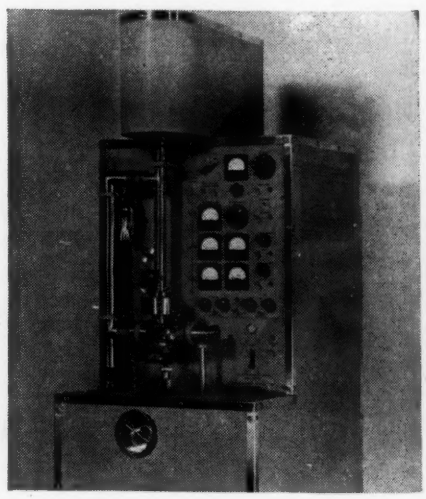
Consisting of a pentagrid converter, high gain audio amplifier, and loudspeaker the Kay-Lab heterodyne detector is used to compare an unknown frequency with that of a signal generator. This system permits comparison of fundamental frequencies over the entire range, thereby eliminating possible ambiguities. The unit will measure signals of 100 microvolts and is usable from 500 cycles to 50 mc. Local broadcast stations may be picked up as frequency standards for checking laboratory oscillators. Audio frequencies may be measured as well as radio frequencies by the zero-beat method.—**Kalbfell Laboratories, Inc., 1076 Morena Blvd., San Diego 10, Cal.**



Signal Tracer

(Use Inquiry Card, Mentioning No. 1106)

Model TS-5 pocket "Stethoscope" signal tracer is comparable in performance to bench type Models TS-2 and TS-3. It will trace a signal through a receiver or other electronic device merely by applying a probe to key points of the circuit. The unit contains its own PM dynamic speaker and has provisions for headphone operation. Any standard type volt-ohm-milliammeter may be plugged in to make an effective rf vacuum tube voltmeter. Model TS-5, which weighs only 3½ lbs. complete, operates on 115 V, 50/60 cycle, ac. It is 4⅛ in. wide, 2⅜ in. deep and 8¾ in. high.—**Feller Engineering Co., 422 S. Dearborn St., Chicago 5, Ill.**



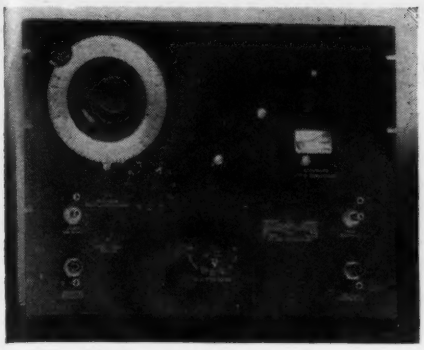
Microoscillograph

(Use Inquiry Card, Mentioning No. 1107)

Making possible the single-sweep recording of three simultaneous phenomena at frequencies up to 10,000 mc, this high-speed microoscillograph extends the frequency range of single-sweep recording by a factor of approximately 10 over previous limits imposed by transit-time distortion. The electron beams are focussed to writing spots of .01 mm diameter, to permit a reduction in size by a factor of 100. Records are made by single-sweep tracing directly on the photographic plate, which is inserted into the vacuum chamber through a vacuum lock. Nine sets of 3, or 27 oscillograms can be recorded on a single 1¼ x 1⅝ in. plate with no overlap. The beam accelerating potential is adjustable in 10,000 volt steps up to 50,000 V. Vacuum is maintained by an oil-diffusion pump backed by a two-stage mechanical pump. Tap water at the rate of 0.3 gals. per minute is required for pump cooling. Power consumption is 1 kva at 115 V, 60 cycles, ac.—**Central Research Laboratories, Inc., Red Wing, Minn.**

ANNOUNCEMENT

For the convenience of readers, all descriptions of new products have been assigned IDENTIFYING NUMBERS. For further information, please use the Prepaid Inquiry Card appearing at page 85 in this issue and *Identify the product by the number assigned to it.*



Capacitance Bridge

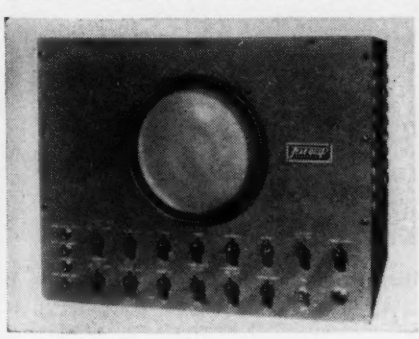
(Use Inquiry Card, Mentioning No. 1108)

Designed to fill the gap between audio-frequency bridges and radio-frequency types, type 716-C capacitance bridge measures capacitance and dissipation at all frequencies between 30 cycles and 300 kc. The circuit is a onventional Schering bridge, using a General Radio precision capacitor as standard, and provided with a shielded input transformer having polystyrene tape insulation. Direct-reading capacitance range is 100 mmfd to 1 mfd at 1,000 cycles and 100 mmfd to 1100 mmfd at the other frequencies. Using the substitution method of measurement, the range extends from 0.1 mmfd to 1,000 mmfd. Dissipation factor range is from .00002 to 0.56. Accuracy is ± 0.2% for capacitance and± 2% for dissipation factor. Applications include measurement of dielectric constant as function of frequency, effect of surface water films on insulators, the Boella effect in resistors, etc. The bridge is supplied either in a walnut cabinet or for rack mounting.—**General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.**

Signal Generator

(Use Inquiry Card, Mentioning No. 1109)

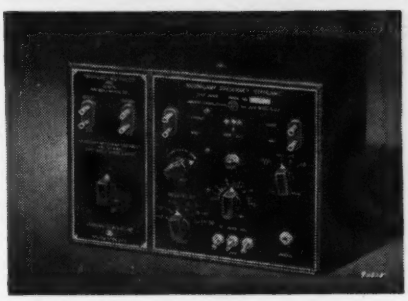
Crystal-control precision is combined with portability in the compact model 117 Mini-Signal generator, which is designed for operation on any 110 volt, ac or dc power supply. In conjunction with the appropriate crystal any frequency from 100 kc to 10.8 mc may be obtained, with harmonic operation possible for higher frequencies. The rf signal can be modulated with an audio frequency of approximately 400 cycles. A continuously variable attenuator and an off-on switch are provided. Premier PL-100 wire-mounted crystals are used, having a precision of ± .05%.—**Premier Crystal Laboratories, 57-67 Park Row, New York 7.**



TV Monitoring Oscillosope

(Use Inquiry Card, Mentioning No. 1110)

Useful in the design and development of television scanning circuits, this monitoring oscilloscope, equipped with a 7GP4 cathode-ray tube, permits the visual examination of various timer and shaper waveforms and their relative phases. Two vertical input channels are provided for the simultaneous examination of harmonically related signals, each channel having a sensitivity of 0.5 V rms per in. of vertical deflection. Separate step and fine attenuators are provided for each channel. Response is uniform from 30 cycles to 4 mc. The horizontal time base is a 60-cycle sawtooth wave, with a selector switch permitting choice of either 98% or 2% duration. External signals for horizontal deflection can be inserted from the front panel. A phase control permits full 360° phase rotation of the time base for the inspection of any portion of the vertical signal. Vertical separation of odd and even lines from zero to 2 in. can be effected by means of a trace separation control pro- supply is built in.—**Telequip Radio Co., 1901 South Washtenaw Ave., Chicago 8, Ill.**



Frequency Calibrator

(Use Inquiry Card, Mentioning No. 1111)

For use in checking transmitter carrier frequencies and station monitors against WWV in compliance with FCC requirements, No. 90515 and No. 90511 frequency calibration units are particularly useful to FM broadcast stations. Model 90515 unit combines the functions of the secondary frequency standard Model 90505 (at right) and the high frequency multiplier and crystal mixer units Model 90511 (at left). The multiplier unit, which is available separately, consists of two double-function 6J6 tubes, both used as double multipliers to obtain an output of 81 mc. This output is mixed with the transmitter signal by means of a 1N34 germanium crystal. Tuning of the multiplier stages is fixed, while the mixer stage is provided with variable tuning from the front panel. The entire assembly is mounted in a cabinet 9½ in. high x 13 in. wide x 10½ in. deep—**James Millen Mfg. Co., 150 Exchange St., Malden, Mass.**

Thermistor Bridges

(Use Inquiry Card, Mentioning No. 1112)

Providing low power rf measurements extending into the microwave region, these two thermistor bridges have good accuracy up to two milliwatts. Type TBN-7SE is designed for continuous duty at normal ambient temperatures, where measurements in S, X and K microwave bands may be made accurately with rf measuring heads. Sensitivity is essentially linear, but a calibration curve is required for each rf head used. The instrument, weighing 14 lbs, is designed for 100-130 volt, 60 cycle. Type TBN-6SE thermistor bridge contains a Wheatstone bridge circuit with three precision resistor arms and requires an external oven and thermistor mount. An amplifier and a stabilized 2000 cycle source for the bridge, as well as a stable dc source for substitution measurement of rf power are provided. Accurate full scale meter readings are possible for 25 microwatts to 2 milliwatts. The instrument is designed for 115 volt, 60 cycle, input. It weighs 54 lb.—**Sylvania Electric Products Inc., 500 Fifth Ave., New York 18.**

Electronic Microammeter

(Use Inquiry Card, Mentioning No. 1113)

Model 301 electronic microammeter provides five sensitivity ranges from .01 to 100 microamps full scale with 40 millivolts fullscale input on all ranges, and cannot be damaged by overload. The instrument can also be used as a null-detecting galvanometer with a sensitivity of 10 millivolts full scale. The instrument contains a dc amplifier, stabilized with negative feedback, having negligible zero drift after warm-up and negligible zero-shift between ranges. The unit operates satisfactorily over an input voltage range of 95 to 130 volts, 50/60 cycles. Full-scale accuracy is 3%, an internal calibration circuit permitting quick "zero-check". Tube line-up includes a 6SC7, 6SL7GT, VR75, and VR90. The instrument has a wide range of applications in the fields of bio-physical research, photoelectricity, ionization gage current measurements, high-resistivity measurements, etc.—**Beta Electronics Co., 1762 Third Ave., New York 29.**

Tube Tester Socket

(Use Inquiry Card, Mentioning No. 1114)

A nine-pin socket, which may be adapted to any Hickok tube tester at low cost, has been made available. Conversion is made by merely drilling a larger diameter hole where the present socket is now located.—**Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio.**

Long-Life Battery

(Use Inquiry Card, Mentioning No. 1115)

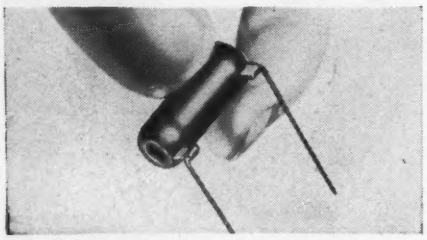
The VSO36 is a sealed-in-steel radio "A" battery especially designed for use in smaller sets and intended to replace ordinary flashlight cells for this purpose. The battery has twice the power life of conventional flashlight cells and does not swell or leak, since it is completely covered by a steel jacket.—**Tube Dept., Radio Corp. of America, RCA Victor Div., Camden, N .J.**

Mismatch Meter

(Use Inquiry Card, Mentioning No. 1116)

The Mega-Match is an electronic instrument for measuring reflected energy over a wide frequency band of 1 to 250 mc and higher. The instrument presents a visual display of reflected energy over any band up to 30 mc. Mismatches between transmission lines, antennas etc. may be observed and measured. The unit, which is provided with a precision frequency meter, does not utilize slotted lines, moving parts, directional couplers, or other frequency-sensitive devices. It may be used to measure input and output impedances of transmissions lines, antennas etc.—**Kay Electric Co., 34 Marshall St., Newark 2, N. J.**

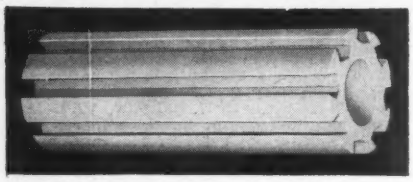
Parts for Design Engineers



Wire Wound Resistors

(Use Inquiry Card, Mentioning No. 1117)

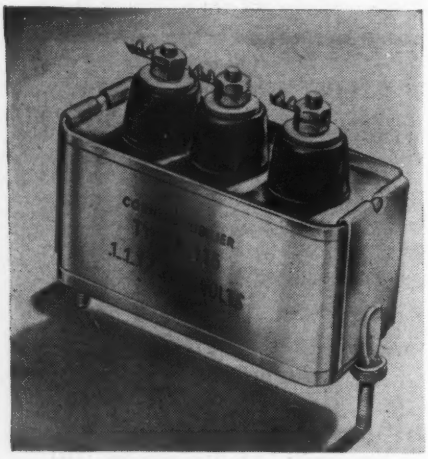
A new 5-watt size has been added to the Brown Devil line of 10 and 20-watt vitreous enameled wire wound resistors. It is available in resistance values of 1 to 10,000 ohms and has a standard tolerance of ±10%. The new size has 1½ in. copper wire leads and is of all welded construction—**Ohmite Mfg. Co., 4952 Flournoy St., Chicago.**



Ceramic Coil Form

(Use Inquiry Card, Mentioning No. 1118)

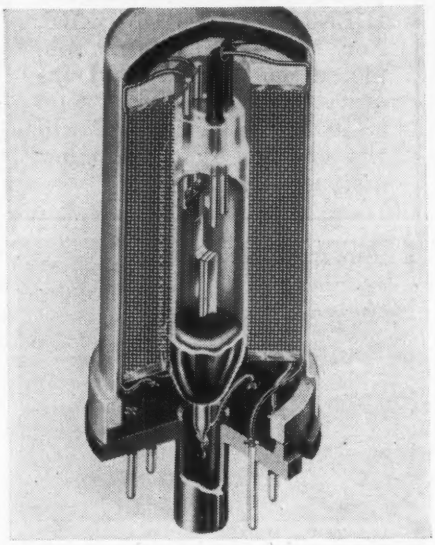
Eliminating the need for special holes to take leads or mount terminals, this fluted steatite coil form may be stocked for universal use regardless of holes required for taps and terminals. The form features dovetail grooves, taking either the tap lead from any part of the winding and passing it down under the turns to either end or taking a spring clip, which slides along the form to any desired point. By means of a metal base, with prongs fitting into the ends of the grooves, the coil form can be mounted in place. For iron core tuning a cap can be snapped over the end of the form and tapped in the center.—**Henry L. Crowley & Co., 1 Central Ave., West Orange, N. J.**



Television Capacitor

(Use Inquiry Card, Mentioning No. 1119)

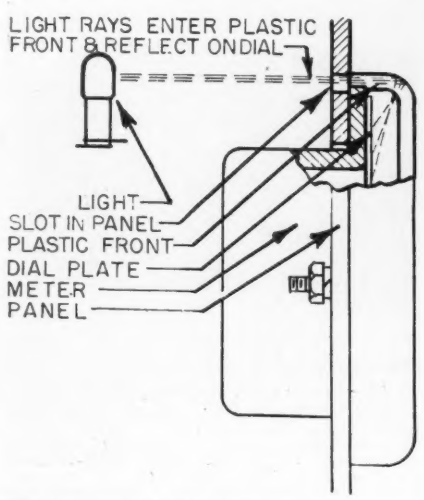
An addition to a line of television and high voltage capacitors, type T-115 is a 3 x .1 mfd. capacitor, rated at 50 V dc working and having dimensions of 1¾ x 3¾ x 2 in. The unit is provided with three high voltage bakelite cone insulated screw terminals with the case common to all sections. The capacitor is impregnated and filled with Dykanol and hermetically sealed in a metal housing.—**Cornell-Dubilier Electric Corp., South Plainfield, N. J.**



Mercury Contact Relays

(Use Inquiry Card, Mentioning No. 1120)

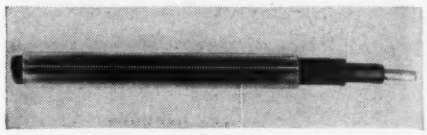
Unaffected by changes in humidity, pressure, temperature, moisture, dirt and corrosion, because they are sealed in gas-filled glass envelopes, Type 275 and 276 mercury contact relays have a life expectancy of more than 10^9 operations when operated within their ratings. The highly sensitive compact units have a repetitive precision within one per cent of their minimum operating current. The use of constantly-replenished mercury wetting of the contact surfaces assures low contact resistance, elimination of chatter and prevention of deterioration of the underlying metal. Total current through front and back contacts should not exceed 5 amps rms on a continuous basis. A metal casing with standard octal base surrounds the sealed-in glass switching units.—**Western Electric Co., 195 Broadway, New York 7.**



Illuminated Meters

(Use Inquiry Card, Mentioning No. 1121)

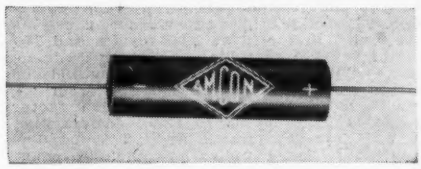
Soft effects result from this indirect method of illuminating clear plastic meters through light directed against the back of the case, piped through the plastic and diffused over the front and dial. The meters are mounted in the usual way. An extra hole in the mounting panel permits light to reach the back of the case. The light bulb, is mounted outside the meter case and at a sufficient distance, so as not to affect the instrument. Models 352 (ac), 351 (dc) and model 103 are available with clear plastic cases for rear illumination.—**Assembly Products Inc., Main & Bell Sts., Chagrin Falls, Ohio.**



Wire Protector

(Use Inquiry Card, Mentioning No. 1122)

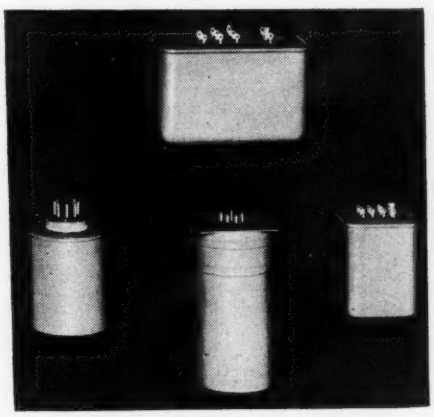
A tough, shatterproof, water repellent transparent wire protector—Snapon Wire Guard—can be installed anywhere and provides efficient protection at friction points. Supplied in 6-ft. sections, any two sections, which may be cut to smaller sizes, interlock and overlap, permitting continuous installations. The protector is molded to fit best over #4 and #6 wires.—**Martin M. Stekert, 45 West 34 St., New York 1.**



Plastic-encased Capacitor

(Use Inquiry Card, Mentioning No. 1123)

Type PLA, a compact tubular electrolytic capacitor measuring only ⅝ in. in diameter and 2⅛ in. in length, has been added to the Amcon line of plastic-encased capacitors. Working voltages range from 25 to 450 VDC. The plastic cases, because of their good dielectric properties, provide better operating efficiency and improved electrical characteristics. — **American Condenser Co., 4410 N. Ravenswood Ave., Chicago 40, Ill.**



Hermetic Sealing

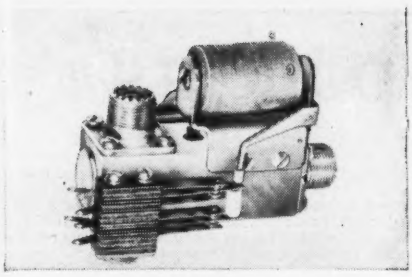
(Use Inquiry Card, Mentioning No. 1124)

The Electro-Seal hermetic sealing process for the protection of electronic and electrical components consists of the following steps: (1) designing of a suitable enclosure, base, brackets and terminals; (2) manufacturing or supplying the component parts; (3) assembling, wiring and sealing these components into the enclosure. A high vacuum exhaust removes moisture and air from the enclosure. Then the enclosure is filled with nitrogen, air or other desired gases or liquids. The illustration shows a few of the standard enclosures now obtainable; others can be designed to specific requirements.—**Electro-Seal Corp., 946 Lee St., Des Plaines, Ill.**

Selenium Rectifier

(Use Inquiry Card, Mentioning No. 1125)

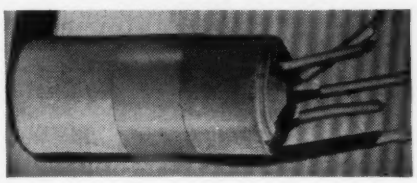
Specifically designed for relays and low current control applications where space is limited, model SE-8M20F selenium rectifier is rated at 110 V ac 80 V dc at 10 ma. The rectifier has a tubular Bakelite case ⅜ in. in diameter x 1½ in. long, with four 2-in. leads. It mounts on two standard screws and is sealed.—**Bradley Laboratories, Inc., 82 Meadow St., New Haven, Conn.**



Coaxial Relay

(Use Inquiry Card, Mentioning No. 1126)

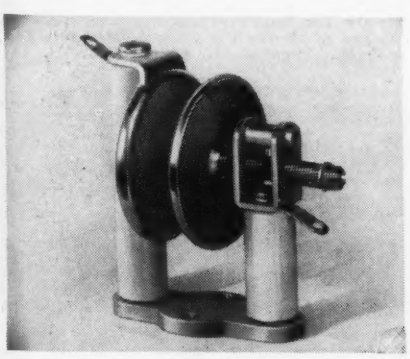
Type 7200 coaxial relays have an rf power rating of 880 watts at 100 mc. This new series of coaxial relays has been designed for SPDT switching of 52 and 75 ohm RG cable. Outside contacts are for auxiliary circuits.—**Advance Electric and Relay Co., 1260 West 2nd St., Los Angeles, Calif.**



High Power Batteries

(Use Inquiry Card, Mentioning No. 1127)

These new high-powered, light weight battery units offer advantages where high power is required with minimum space and weight. Standard Type A.M. units can deliver up to 30 watts per cubic in. and 360 watts per pound; they can be stored without deterioration. Voltage is maintained nearly constant throughout the life of the units. Supplied in dry form, they are readily activated by brief immersion in water. Standard units are available from 1.5 to 112 V, in capacity ratings up to 18 ampere-hours, and with power ratings up to 2.8 kw.—**Burgess Battery Co., A.M. Dept., Freeport, Ill.**



Neutralizing Capacitor

(Use Inquiry Card, Mentioning No. 1128)

NZ-10 neutralizing capacitor provides a long leakage path between the plates and ground. The unit is designed to neutralize any tube having a grid to plate capacitance of 10 mmfd or less. Maximum capacity is 10 mmfd, minimum 2.3 mmfd. Plate spacing is adjustable from 1/16 to 5/8 in. Peak voltage rating is 3000 at minimum gap. The locking device and rotor adjustment may both be operated by a screwdriver.—**Hammarlund Mfg. Co.,** 460 W. 34 **St., New York 1.**

Electrolytic Capacitors

(Use Inquiry Card, Mentioning No. 1129)

Midget-can electrolytic capacitors, heretofore available in voltage ratings up to 450 dc working, are now also being supplied in higher voltage ratings of 500, 600, and 700 dc working, or 650, 750, and 850 surge volts respectively. Capacitance values are 8, 10, 12 and 16 mfd. Container sizes are compact, consistent with the original PRS Dandee line. The units are electrically insulated with special waxed-paper jacket, the ends being spun over the can rim, to eliminate the possibility of shorts, if leads are bent close to the units.—**Aerovox Corp., New Bedford, Mass**

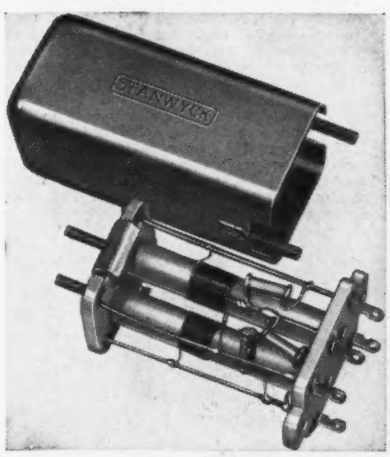
ANNOUNCEMENT

For the convenience of readers, all descriptions of new products have been assigned IDENTIFYING NUMBERS. For further information, please use the Prepaid Inquiry Card appearing at page 85 in this issue and *Identify the product by the number assigned to it.*

Variable Capacitors

(Use Inquiry Card, Mentioning No. 1130)

This line of variable capacitors features butterfly rotor construction to permit grounding rotor at center of rf voltage point and includes opposed stator sections to provide short rf paths. JCX units are constructed of stainless steel shafts and tie rods, heavy rounded aluminum plates and high quality insulating materials. Three standard types are available, having capacities of 100 mmfd., 50 mmfd., and 25 mmfd. per section.—**Barker & Williamson Inc., 237 Fairfield Ave., Upper Darby, Pa.**



Miniature IF Transformer

(Use Inquiry Card, Mentioning No. 1131)

Specially molded iron cores provide high "Q" for this line of low-cost midget IF transformers. Specially treated mica compression trimmers are used to maintain stability and facilitate alignment. Capacity coupling between windings is minimized due to the high dielectric constant of the platform material. The windings on the iron cores are formex wire to provide high breakdown resistance. The units are prealigned to 455 kc. They are mounted in a can ¾-in. square x 7⅞ in. high.—**Stanwyck Winding Co., 102 South Landers St., Newburgh, N. Y.**

Multi Contact Relay

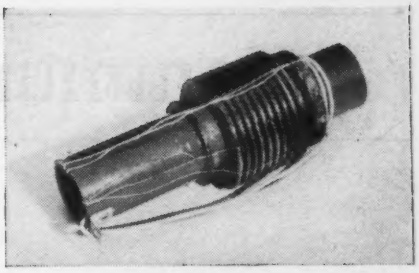
(Use Inquiry Card, Mentioning No. 1132)

Designed primarily for appliances, vending machines, etc., this multi-contact ac relay is available in ratings of 5 amps., 115 volts, ac, or 5 amps., 24 volts, ac. The two-circuit relay occupies only three cubic inches and is quiet in operation. All ferrous parts are protected from corrosion. The molded phenolic insulators have stable dielectric strength and provide 1/16 in. creeping between adjacent contact springs.—**General Electric Co., Schenectady, N. Y.**

Radio Control Designations

(Use Inquiry Card, Mentioning No. 1133)

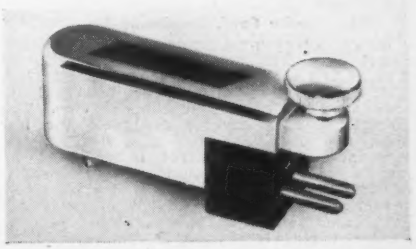
A decalcomania form with radio broadcast words is available for identifying equipment controls. The words, such as AUDIO, ON, OFF, MIXER, VIDEO, etc., are clipped out, moistened and rolled on near the control. The letters are gilt, edged in black. **M. J. Weiner, 565 5th Ave., N.Y.C.**



RF Power Supply Coils

(Use Inquiry Card, Mentioning No. 1134)

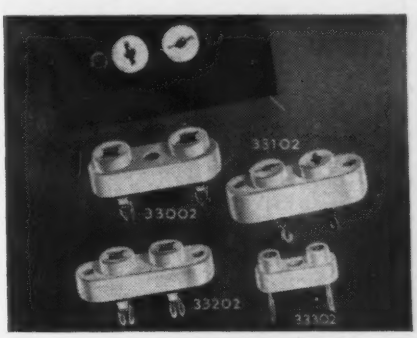
This line of rf power supply transformers is designed for use in television receivers, cathode-ray oscilloscopes and other equipment requiring a safe low-current, high voltage source of power. Sizes available are: 1, 2.5, 4, 5, and 10 kv. All are conservatively rated at 250 microamps., and each includes primary, secondary, feedback and rectifier filament windings. All coils are Q-max treated. A circuit diagram is included with each coil.—**Electronic Engineering Service, Box 72, Ridgewood, N. J.**



Pick-up Adapter

(Use Inquiry Card, Mentioning No. 1135)

The Vibromaster type M adapts the Western Electric 5A arm to accommodate the GE variable reluctance or the Pickering 120M cartridges. The adapter is interchangeable with 9A heads and provides correct balance when used with the 5A arm and either cartridge. No soldering is necessary for attachment to cartridge lugs. Output of the cartridges at 10 cm. per second stylus velocity is 25 millivolts for the Pickering and 11 millivolts for the GE.—**Technical Products International, 453 West 47 St., New York 19.**



Crystal Holder Socket

(Use Inquiry Card, Mentioning No. 1136)

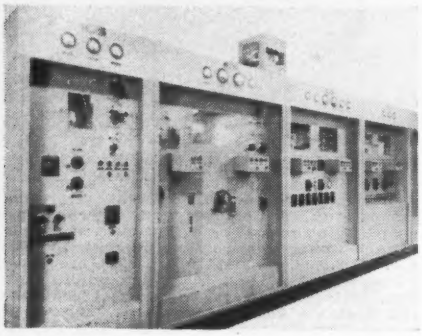
Designed specifically for use with the midget hermetically sealed CR7 crystal, No. 33302 crystal holder socket is made of steatite and has contacts of silver plated phosphor bronze. Pin spacing from center to center is 0.5 in., pin diameter 0.05 in. The illustration shows sockets for every type of crystal holder.—**James Millen Mfg. Co., 150 Exchange St., Malden 48, Mass.**

Automatic Selector Switch

(Use Inquiry Card, Mentioning No. 1137)

In this new application the Ledex rotary solenoid is utilized for driving the rotor of a circuit selector switch. The rotary solenoid is converted to a rapidly oscillating motor by means of a commutating switch, synchronized to close and open at the start and end of the energized stroke. Through an end-engaging type rachet, the oscillating motion drives the rotor assembly of a gang of multiple circuit selector switches. The solenoid, which operates on dc, is available in various values of stroke up to 95°.—**G. H. Leland Inc., 123 Webster St., Dayton 2, Ohio.**

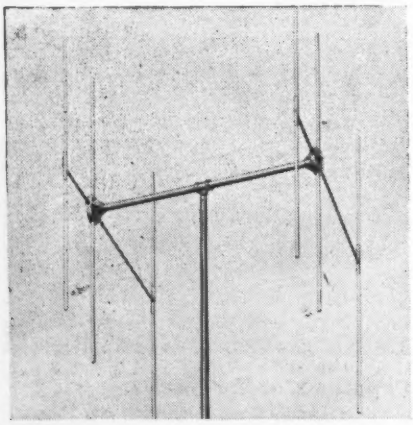
Communications Components



International Broadcast Transmitter

(Use Inquiry Card, Mentioning No. 1138)

Quick, continuous tuning from the front panel over its entire frequency range of 2.85 to 22.5 mcs. is a feature of this 20 kw, CW or FS transmitter, for international broadcast and communications service. The circuit includes inverse feedback for low noise and distortion and high fidelity performance. Crystal control is provided by means of a six-position crystal switch; crystal frequency range is 2.85-7.5 mc. Power output is 20 kw on CW or frequency shift, and 15 kw on phone. Frequency response varies less than 2 db from 30 to 10,000 cps. An audio input level of 6 milliwatts (500 ohm balanced input) produces 100% modulation at 1000 cps. On-off keying speed is 400 wpm; frequency shift keying 700 wpm or better. The tube line-up includes: 4—866A's, 8—872-A's, 6—575A's, 3—807's, 1—813, 1—HK854, 1—880, 4—6SJ7's, 2—828's, 2—889R's, 1—0Z3VR-105, and 2—0D3/VR150's. Protective circuits comprise mechanical and electrical interlocks, recycling and overload relays. The illustration shows exciter, low voltage rectifier, power amplifier, modulator and high voltage rectifier.—**J. H. Bunnel & Co., 81 Prospect St., Bklyn. 1, New York.**



High-Gain Directional Antennas

(Use Inquiry Card, Mentioning No. 1139)

Designed for point-to-point communication work in repeater and relay station hook-ups these high gain directional antennas are available in three models, one each for the 152-162 mc, 72-76 mc and 30-40 mc bands. The antenna is a 6-element array with two driven elements. Half wave spacing between the bays, which are fed in phase, eliminates nearly all side radiation. The gain is rated at 7.6 db; when used in pairs, overall gain of the system is 15.2 db. The antenna, made of ½-in. aluminum alloy elements, is supplied with branch cables connected and sealed against weather inside the supporting mast, which is made of 1½-in. steel pipe. Impedance is matched —with low standing wave ratio—to all types of 50-ohm transmission lines. A complete line of connectors and adaptors is available.—**The Workshop Associates, 66 Needham St., Newton Highlands 61, Mass.**

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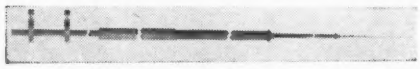
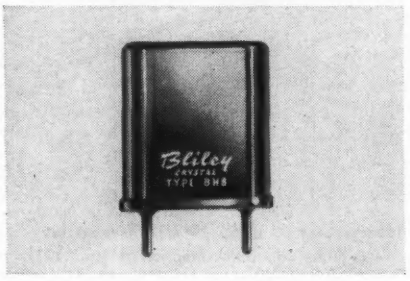


Coaxial Antenna

(Use Inquiry Card, Mentioning No. 1140)

Capable of handling power inputs up to 250 watts, RSMC coax antenna is available for frequencies between 30 and 200 mc. Constructed of aluminum and steel tubing, the unit is easily taken apart for maintenance and can be supported on a roof ridge, top of a tower or stick type pole. Standing wave ratio is no greater than 1 to 1.25, when the antenna is connected to a source of properly tuned rf energy through a 75-ohm concentric line. Antenna weight is 12 lbs.—**Radio Specialty Mfg. Co., Portland, Oregon.**



VHF Crystal

(Use Inquiry Card, Mentioning No. 1141)

The BH6 crystal, operating in the 15-100 mc range, utilizes a paper-thin silver-plated quartz plate. Operation is on third, fifth and seventh overtones. A pair of ceramic rings clamp the quartz plate rigidly in position.—**Bliley Electric Co., Erie, Pa.**

Amateur Exciter

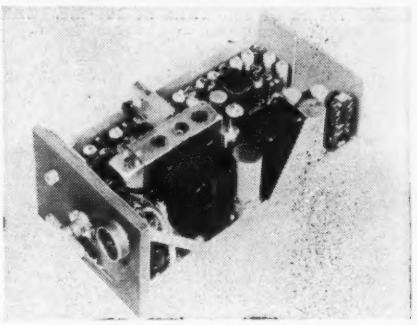
(Use Inquiry Card, Mentioning No. 1142)

Absolute frequency retrace may be obtained with Model 500 VFO exciter by beating the fifth harmonic of the 2 mc fundamental with WWV on 10 mc. The unit consists of a vfo followed by four multiplier tubes and an 807 output stage which provides sufficient power to drive the new power tetrodes to 1 KW input or triodes up to 300 watts input. Multiplier plate circuits are of the band-pass type and do not require tuning. Each unit is temperature cycled for drift compensation and is supplied with calibration chart. Oscillator stability is virtually unaffected by line voltage changes up to 25%. Model 502 VFO complete with dial assembly may be obtained separately; it is capable of driving a 6L6 or similar tube.—**Barker & Williamson, Inc., 237 Fairfield Ave., Upper Darby, Pa.**

Audio Cabinet Rack

(Use Inquiry Card, Mentioning No. 1143)

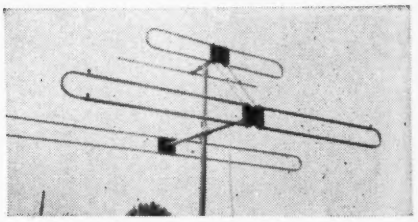
Type FA-8-A audio cabinet rack is 20⅝ in. wide and 83⅛ in. high. It is 15⅝ in. deep and provides a 19 in. wide by 77 in. high panel mounting space with 14 in. clearance behind the panels. Constructed of sheet steel with an open front and a hinged door on the rear, the cabinet is drilled and tapped with No. 12-24 holes in accordance with proposed RMA standards. A rectangular opening in the top provides ventilation. —**GE Electronics Dept., Transmitter Div., Electronics Park, Syracuse, N. Y.**



Radiotelephone Dispatcher

(Use Inquiry Card, Mentioning No. 1144)

Designed for the 152-162 mc band, this single unit FM mobile radiotelephone transmitter has a power output of 7-10 watts, crystal drift is held to less than ±.002% over a temperature range of —20 to +80° C. Interference and spurious responses are kept to a minimum through multiple pre-selection, special shielding and carefully engineered circuits. In operation the transmitter-receiver standby drain is 9.2 amps. The unit is equipped with a single control cable and small control head, which includes microphone connector and hang-up switch. Small size of 17 in. x 8½ in. x 5¾ in. has been achieved through use of miniature tubes and a single vibrator power supply for both transmitter and receiver. Weight of the unit is 27 lbs.—**Motorola Inc., 4545 W. Augusta St., Chicago 51, Ill.**



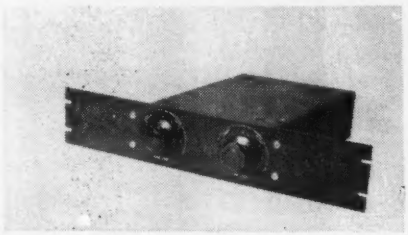
Television Antenna

(Use Inquiry Card, Mentioning No. 1145)

The type TFM-200 (without reflector) and type TFM-300R (with reflector) television and FM antennas are designed to provide maximum response on all 13 television channels between 44 and 216 mc as well as giving efficient FM reception on all channels from 88 to 108 mc. Flat frequency characteristics have been achieved by connecting two broad band dipoles by means of frequency-selective circuits to a common transmission line which may have an impedance from 73 to 300 ohms. Model TFM-300R (illustr.) has a constant unidirectional reception pattern approximating a half figure "eight" for all television channels. Model TFM-200 has a directional pattern approximating a figure "eight", similar to a tuned dipole. Both models are corrosion resistant aluminum for the mast support and dipole U shaped rods.—**Collins Machine Co., 56-21 Northern Blvd., Woodside, N. Y.**

LOOK FOR NEW TYPES OF ELECTRON TUBES ON PAGE 76

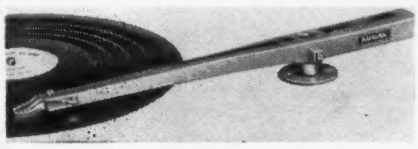
Sound and Recording Equipment



Audio Compensator

(Use Inquiry Card, Mentioning No. 1146)

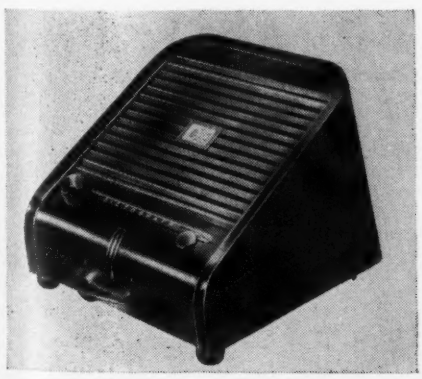
This audio equalizer consists of a two-stage "RC" amplifier utilizing type 1620 tubes. It requires a 6.3 V, 0.6 amps. "A" supply, and a 180-250 V dc, 4 ma "B" supply. The variable low frequency control provides a maximum attenuation of approximately 22 db and a maximum boost of 9 db at 30 cps. The high frequency control is adjustable to provide a maximum gain of approximately 9 db or an attenuation of 17 db at 10,000 cycles. The equipment is normally connected for zero insertion loss at 1 kc, but is capable of providing up to 25 db gain with both controls in the zero position. Input level is —25 dbm; input and output impedances of 500, 333, 250, 200, 125 or 50 ohms are available. Noise level is —90 dbm; max. harmonic distortion at 500 cps —0.15%.—**Arlington Electrical Products Inc., 18 W. 25 St., New York 10.**



Tuned Ribbon Reproducer

(Use Inquiry Card, Mentioning No. 1147)

Model Studio-81, one of the new Audax tuned-ribbon reproducers, has a linear response to over 10 kc, and is fitted with a special diamond stylus. Its output is adequate for most amplifiers. The dynamic mass of the unit is very small, point pressure being 14 grams. Magnetic-cushioned tracking and absence of torsional action are characteristics.—**Audax Co., 500 Fifth Ave., New York City.**



Intercommunication System

(Use Inquiry Card, Mentioning No. 1148)

This low-priced electronic intercommunication system, supplied in a streamlined cabinet of black plastic, is intended for small offices and plants, requiring not more than four substations. The "Black Beauty" master station is available in 1-2-3-4 point hookup with substations with or without the callback feature.—**Dictograph Products, Inc., 580 Fifth Ave., New York 19.**

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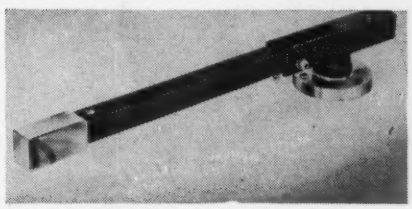
Portable Electric Megaphone

(Use Inquiry Card, Mentioning No. 1149)

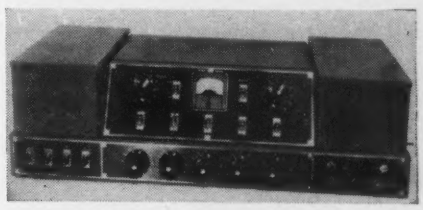
This portable electric megaphone consists of a megaphone which amplifies and projects the voice and a battery case power supply. The megaphone comprises a permanent-magnet double re-entrant type speakers, and a dynamic microphone and two-stage amplifier built into the speaker housing. An "on-off" trigger switch is in a pistol-grip handle. The horn is 12 in. long and has a 10-in. diameter bell opening. Microphone and amplifier are shock-mounted. The battery case contains one 1½-volt A battery and three 45-volt B batteries. The case measures 6½ in. in width, 5¼ in. in height, and 3½ in. in depth. The combined weight for both units is only 13½ lbs.—**Phil-Mar Mfg. Co., 6517 N. Clark St., Chicago 26, Ill.**



Tone Arm

(Use Inquiry Card, Mentioning No. 1150)

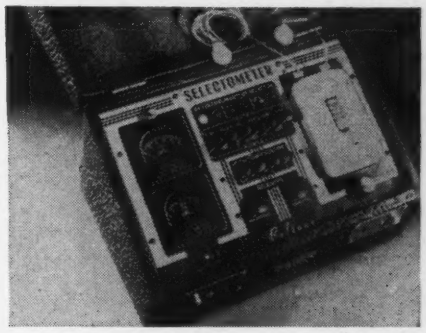
Designed for use in conjunction with the GE variable reluctance cartridge, this all aluminum tone arm, Model G-1, is of rigid construction, equipped with a ball bearing, is non-resonant, free-floating and balanced. Stylus pressure, with the cartridge installed, is approximately 24 grams. The head is removable. Overall length is 16 in.—**Barber & Howard, East Ave., Westerly, R. I.**



Speech Input Equipment

(Use Inquiry Card, Mentioning No. 1151)

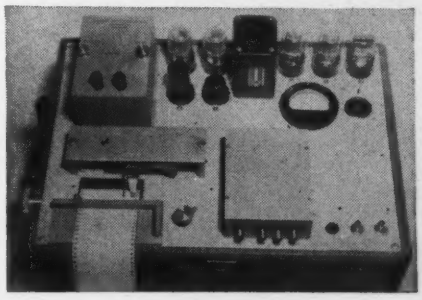
The 23C speech input equipment provides at low cost a complete ac-operated amplifier and control console assembly, capable of serving either one or two AM or FM broadcasting studios. It contains a five-channel high-level mixing circuit for blending and controlling level simultaneously on four microphone input circuits, and one input circuit for incoming program lines. Each of the microphone inputs has separate premixing amplifiers. The mixer is followed by a three-stage main amplifier with master level control. The unit may be used alone or as part of a coordinated program production system.—**Western Electric Co., 195 Broadway, New York, Distr. by Graybar Electric Co., New York.**



Hearing Aid Selection

(Use Inquiry Card, Mentioning No. 1152)

Designed to enable a deafened person to choose his own hearing aid, the "Selectometer" permits the trying out of more than 140 different combinations of acoustical gain, power output and frequency response. The device allows quick switching between the various combinations of tubes, receivers, and electronic circuits used in Beltone hearing aids, so that the person being fitted can select for himself the precise combination with which he hears best.—**Beltone Hearing Aid Co., 1450 West 19 St., Chicago, Ill.**

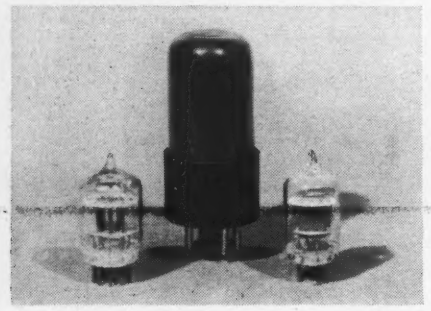


Power Level Recorder

(Use Inquiry Card, Mentioning No. 1153)

Model PL high-speed power level recorder has been redesigned to provide several mechanical and electrical advantages over the previous version. Three pushbutton operated paper speeds are now available. Model HPL also provides easier accessibility to the recording mechanism, scriber and potentiometer train. The price of model HPL has not been increased over that of model PL.—**Sound Apparatus Co., 233 Broadway New York 7.**

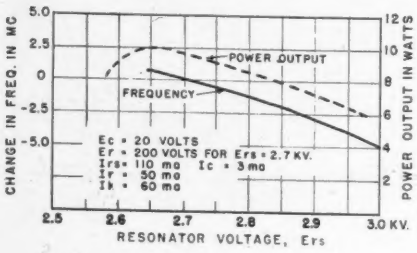
New Types of Electron Tubes



MINIATURE DUAL TRIODE

(Use Inquiry Card Mentioning No. 1154)

A new miniature double triode has been developed by Bell Telephone Labs and is being produced as No. 396A (coded 2C51 by RMA). The tube differs from other dual triodes in two respects; it has separate cathode connections for each triode section, requiring a new form of base with 9 pins instead of the standard miniature 7-pin type; it is ⅞ -in. in diameter instead of the usual ¾ in. Operating conditions and characteristics are: Heater rating, 6.3 V, 0.30 amp; plate voltage 300, current 18 ma. The tube has been developed for application in multiplex telephony transmission circuits and for other purposes where the two triode sections may be independently operated because of a shield between sections. **Bell Telephone Laboratories, New York.**



SECONDARY EMISSION KLYSTRONS

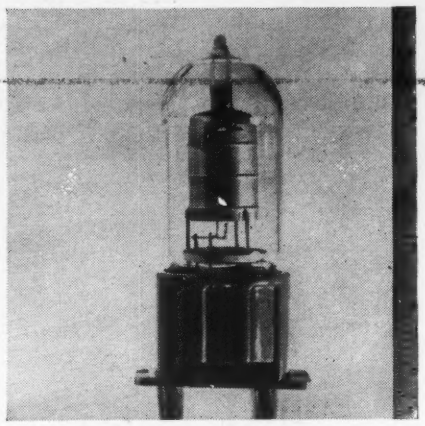
(Use Inquiry Card, Mentioning No. 1155)

The 2K51-53 secondary emission velocity-modulation oscillators are similar to the 417A reflex klystron except that the surface of the reflector electrode consists of a good secondary emitter, thus providing higher efficiency and increased power output. A positive voltage from 0-500 V instead of the usual negative voltage is applied to the reflector electrode. When a bunched electronic current strikes the secondary emitter, a much greater bunched electronic current is emitted and returns to the resonator, delivering a correspondingly greater amount of power to it. Inefficiencies due to debunching and divergence of the electronic beam from the secondary emitter are low due to the short drift distance to the resonator. This makes the tubes efficient as easily tuned, low-power transmitters having power output in the order of 10 watts and efficiency of 3 to 5%. The tubes operate with 6.3 V heater voltage at 1.4 amps. Mechanical tuning range for the 2K51 is 2700-3300 mc, for the 2K52, 2900-3700 mc, and for the 2K53 3200-4000 mc; electronic tuning range is 40 mc for each tube. Resonator voltage range is from 1500-3000 V., grid voltage range from 0-150 V.—**Electronics Dept., Westinghouse Electric Corp., Bloomfield, N.J.**

DIRECT VIEWING PICTURE TUBE

(Use Inquiry Card, Mentioning No. 1156)

The Rauland 10FP4/R6025 picture tube with aluminized reflector-screen has increased brilliance with a high-light brightness of 50 foot lamberts. The aluminized screen also eliminates cathode glow and the raster movement, as well as providing superior contrast range. An external conductive coating serves as a filter capacitor for the anode voltage source when rf or flyback type power supplies are used. The tube, which has electromagnetic deflection and focusing, operates at 6.3 V filament with a current of 0.6 amps. The medium persistence P4 screen is used. Maximum anode voltage is 11,000.—**The Rauland Corp., 4245 No. Knox Ave., Chicago 41, Ill.**



HIGH-ALTITUDE RECTIFIER

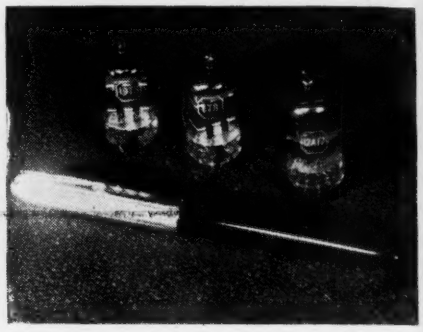
(Use Inquiry Card, Mentioning No. 1157)

Especially important in control circuits of guided missiles a new type high vacuum, half wave rectifier has been designed for use on high voltages at altitudes up to 60,000 ft. To prevent flash-over all air has been excluded by a specially constructed base of glass, tapered and ground to fit the socket like a glass bottle stopper. The tube socket, made of Mycalex is the exact counterpart of the base, having the same large taper angle to avoid trapping of air, when the tube is plugged into the socket. The original rectifier tube, designed for the Air Forces, is rated at 14,000 V peak inverse, though the tube-socket combination will handle voltages as high as 35,000 V peak. It can deliver an average plate current of 125 ma, peak current being 750 ma. When used in radioactive areas, tubes of this design will not break down externally due to ionizing action.—**Amperex Electronic Corp., 25 Washington St., Bklyn., New York.**

INDUSTRIAL HEATING TUBE

(Use Inquiry Card, Mentioning No. 1158)

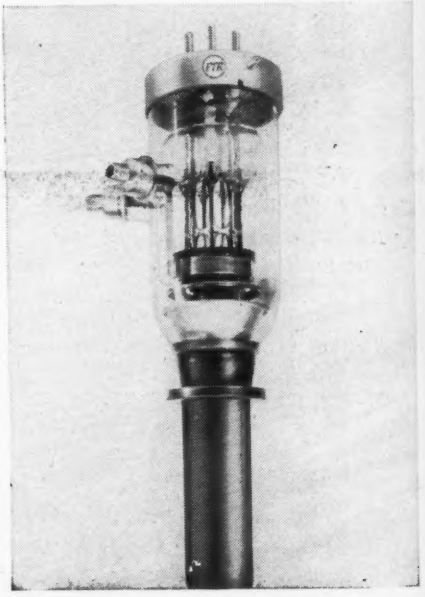
Developed for industrial dielectric heating applications type 7C25, 2500-watt oscillator tube measures 3½ in. in diameter and 7 in. in height with flexible tube leads 6 in. in length. Two 7C25's in a coupled circuit will give a power output of 4½ to 5 KW at frequencies up to 50 megacycles. Maximum plate voltage is 4500 volts. With a thoriated tungsten filament the tube operates at 11 volts filament voltage and consumes 27.5 amps. Radial cooling fins with large surface areas and unrestricted air flow provide efficient forced-air cooling of the anode. Minimum air flow for cooling is 150 cu.ft. per minute. — **Federal Telephone and Radio Corp., Clifton, N. J.**



MINIATURE RECEIVING TUBES

(Use Inquiry Card, Mentioning No. 1159)

Developed especially for use in FM and television receivers, Types 6T8, 19T8 and 12AT7 nine-pin miniature tubes are ⅞ in. wide and 2-3/16 in. long. The 12AT7 is a twin triode, efficient for use as a grounded-grid rf amplifier or as frequency converter at frequencies below approximately 300 mc. A center-tapped heater permits operation of the tube from either a 6.3 V or 12.6 V heater supply. Both the triple-diode triodes 6T8 and 19T8 contain three high-perveance diodes and a high-mu triode in the same envelope. One of the diodes has a separate cathode connection. The heater of the 6T8 is for 6.3 V operation at 450 ma, while the 19T8's is designed for 18.9 V operation at 150 ma.—**Tube Div., GE Electronics Dept., Schenectady, N. Y.**



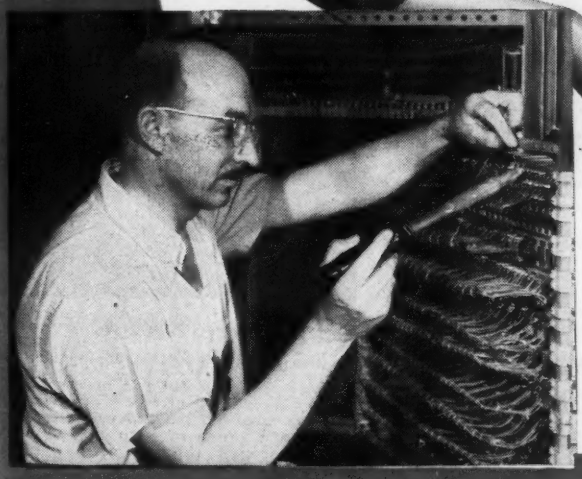
TRANSMITTING TRIODES

(Use Inquiry Card, Mentioning No. 1160)

Type 9C30 (illustrated) heavy duty AM broadcast tube, which has a thoriated tungsten filament and is designed for RF amplifier application at frequencies up to 20 mc, operates at 15 V filament voltage and 135 amps., current and has maximum ratings of 15,000 V plate voltage; 8 amps plate current; 120 kw plate input; and 40 kw plate dissipation. The tube is watercooled and requires a minimum flow of 15 g.p.m. Forced-air cooled type 9C31 operates at the same filament voltage and current and is designed for the same applications, but has a maximum plate input of 100 km and a maximum plate dissipation of 20 kw. Other maximum ratings are the same. Air-cooled transmitting triode Type 7C30, also recently brought out, is designed for use as rf power amplifier and oscillator and has a plate dissipation of 3 kw maximum. The thoriated tungsten filament operates at 16V with a current of 28.5 amps. Maximum plate voltage is 6000 V; plate current 2 amps; and plate input 12 kw.—**Federal Telephone and Radio Corp., Newark 4, N. J.**

2,500,000 SOLDERED CONNECTIONS*

"Wow! This job sure keeps me hopping!"



"BELIEVE me, fitting [illegible] dial and manual switchboard equipment and long [illegible] facilities in Bell System central offices all around the country is keeping me mighty busy!

"In a single big dial exchange there may be 4,000 miles of wire. I may have to solder 2,500,000 connections before everything's ready for you to dial a number.

"Besides *installing* this complex apparatus, I buy it. That's part of my job as *manufacturer's* [illegible] Bell System [illegible] of things for the Telephone Companies... and *distribute* these supplies to them along with the equipment I make.

"Ever since 1882, I've been helping to make our nation's telephone service the best in the world. Today...with the Bell System's construction program of more than $2,000,000,000 in full swing . . . I'm busier than ever.

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These G-E INDUSTRIAL SOLDERING IRONS are built for heavy-duty, continuous service. Famous Calrod† heaters assure fast, dependable heat and long life. Ironclad-copper tips have calorized threads to prevent "freezing in." Simplified disassembly features make them easy to maintain right on the spot.

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3½-inch SPEAKER
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5¼-inch SPEAKER
6½-inch SPEAKER
4x6-inch SPEAKER

THE CRESCENT *Speakers*

.....designed and engineered to the most exacting standards, deliver the finest in tonal performance.

The most attractive and well designed changer in the popular priced field. Equipped with dependable cushion mounted motor — "Barry" mounts to eliminate vibrations and fool-proof in operation. Hammertone finished with smart plastic trim. Has both reject button and control knob for convenient on-off-manual and automatic operation. Plays 10" or 12" records automatically.

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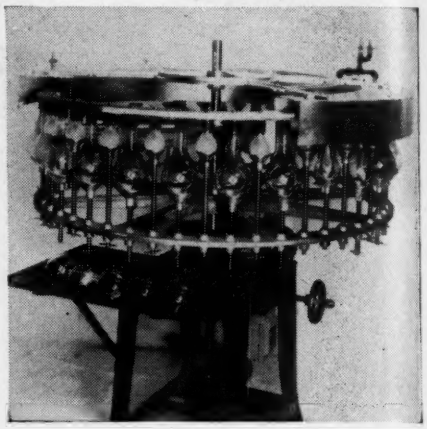
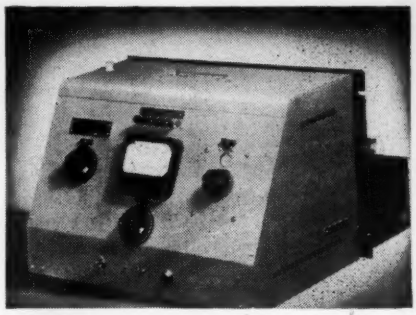
WHAT'S NEW



Tube Basing Machine

(Use Inquiry Card, Mentioning No. 1161)

Capable of holding and basing simultaneously large and small types of incandescent lamps and electronic tubes, this 50-head type basing machine consists of a sturdy table structure to which a vertical driveshaft is centrally attached. The drive shaft carries, between collars, the top spider and oven spider, and indirectly, by means of an interposed tube, the lower spider. The machine is powered by a ¼ HP motor with variable speed drive and is fully automatic. The operator's job consists only in inserting the prepared lamps or tubes into holders and removing them after passage through the oven. Production of the machine is approximately 600 to 1000 per hour depending on the size of the bulbs.—**Eisler Engineering Co., Newark 3, N. J.**



Capacitance Bridge

(Use Inquiry Card, Mentioning No. 1162)

Particularly useful for measuring capacitance in multielectrode systems including vacuum tubes, Type 125 capacitance bridge provides a range of 0 to 100 mmfd in five scales through the use of five multipliers and a measuring frequency of 465 kc. Direct capacitance accuracy is 1% and direct conductance accuracy is 10%, when calibration is performed with standards of commensurate accuracy. The bridge consists of three separate sections including rf signal generator and power supply, rf amplifier, detector and vacuum tube voltmeter. The instrument measures 19 in. long x 12¼ in. high. It operates on 110-120 V, 50-60 cycle. —**Sylvania Electric Products Inc., 500 Fifth Ave., New York 18.**

FM Transformer

(Use Inquiry Card, Mentioning No. 1163)

This new transformer for FM receivers is composed of high frequency ceramic throughout and has specific applications for the manufacturers of small tuners or high fidelity combinations. The transformer assembly uses two independent ceramic tubes for primary and secondary eliminating "top and bottom" tuning. The iron cores used reach their peak "Q" values at the center frequency of 10.7 mc. All of the ceramic condensers are of the compensating type. The substantial roll-over of the mounting lugs against the ceramic results in minimum breakage of bases. Extreme uniformity of wave shape is attained over a wide production range in the discriminator.—**Stanwyck Winding Co., 102 South Landers St., Newburgh, N. Y.**

RAYTHEON chosen for

Simultaneous AM-FM Programing

Here's how a key CBS network originating station, WHP, Harrisburg, has set up to handle all Pennsylvania public interest programs, and in addition, to feed two separate programs to its AM and FM outlets.

With a dual installation of Raytheon RC-11 Studio Consoles, WHP has facilities which provide:

a. Four outputs . . . AM, FM and two channels for feeding networks

b. Four individual programs can be simultaneously originated

c. Complete Quadruplex monitoring, talkback and cueing

d. Console inputs so wired that all studios, news room and remotes can be mixed into a common output, thereby enabling multi-point origination of special events shows at a moment's notice —

Raytheon Speech Input Equipment and AM and FM Transmitters in a 250 to 10,000 watt range, provide high fidelity, servicing accessibility and low-cost maintenance. Write for illustrated bulletins and technical data.

Mr. Dan Leibensperger, Chief Engineer of WHP examining their new dual Raytheon installation.

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This is the name applied by his customers to Henry J. Geist, New York representative on Raytheon Broadcast Equipment. He earned it by helping stations procure speech input and transmitter equipment . . . also microphones, turntables, meters and crystals . . . almost as fast as you can say "Raytheon." What Hank does for his customers, can be done for you . . . by the nearest Raytheon representative listed below:

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WHAT'S NEW

Portable Public Address

(Use Inquiry Card, Mentioning No. 1164)

Built to the same specifications as its military forerunner, the PA-4 portable public address system has a high-gain, three-stage amplifier, crystal microphone and a heavy duty 6-in. permanent field speaker. It utilizes three tubes and three long-life batteries. Dimensions are 9 in. high, 7½ in. wide, and 12 in. deep. Weight with batteries is 12 lb.—**Siltronic Co., Point Bldg., Pittsburgh 22, Pa.**

Pilot Light Assembly

(Use Inquiry Card, Mentioning No. 1165)

This candelabra base, 110 volt, pilot light assembly may be secured by clip-on or snap-in brackets for panels up to .078 in. thick. The assembly is provided with a rugged bakelite insulating shell and is furnished with leads soldered in any length to meet specifications. It is listed in Underwriters' File No. E-107093.—**Micarta Fabricators, Inc. 5324 N. Ravenswood Ave., Chicgo 40, Ill.**

Neon-Glow Indicators

(Use Inquiry Card, Mentioning No. 1166)

This new line of standard neon-glow lamp indicators is designed primarily for use as sub-assembly for electrical equipment requiring a lighted indicator. The units are supplied to meet a wide range of requirements in method of mounting, visibility, appearance and light brilliance. They consist of a heat-resisting outer housing, mounting bracket, neon glow lamp and proper resistance for operating on voltages of more than 70 volts, either ac or dc.—**American Electronics Corp., 226 No. Fourth St., Columbus, Ohio.**

Distortion Meter

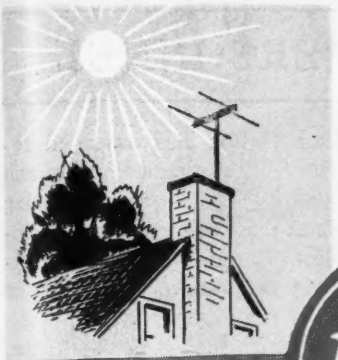
(Use Inquiry Card, Mentioning No. 1167)

Model 400 light-weight distortion meter consists of a Wien bridge null balance included in a feedback amplifier in combination with a sensitive vacuum tube voltmeter and calibrated attenuator. The instrument is provided with a single frequency suppression circuit for fundamental frequencies from 50 to 15,000 cps. and permits measurement of harmonics up to 45,000 cycles. As voltmeter and db meter the frequency range is 30 to 30,000 cycles. For noise and distortion measurements a minimum input of .3 volts is required. Four ranges are from .5 to 3%, 3—10%, 10—30%, and 30-100% distortion; and from .003 to .3 volts full scale as voltmeter; noise range is from —50 to —10 db. Input and output terminal impedances are 100,000 ohms each. —**Barker & Williamson, Inc., 237 Fairfield Ave., Upper Darby, Pa.**

High-Voltage Cathode-Ray Equipment

(Use Inquiry Card, Mentioning No. 1168)

Taking advantage of the rapid writing rates of Type 5RP multi-band tube, this oscillographic equipment consists of Type 281 high-voltage cathode-ray indicator and Type 286 high-voltage power supply, available together or separately. When type 286 is used as auxiliary supply to the indicator, the overall accelerating potential applied to Type 5RP-CR tube is 29 kv, permitting writing rates as high as 400 in. per microsecond. Since the sensitivity is high, the 5RP-A may be operated with ordinary amplifiers. Capacitive and direct connections are provided to the deflection plates for both X- and Y-axes. Z-axis signals may be applied to either cathode or grid of the tube. The instrument has complete magnetic shielding. The power supply, consisting of an rf oscillator, step-up transformer, voltage-doubler rectifier, filter, output meter and regulator circuits, provides a dc output voltage variable from 18 to 25 kv.—**Allen B. DuMont Labs., Inc., Clifton, N. J.**



In SUN, WIND, SLEET or RAIN

FEDERAL'S 300-OHM LINE

gives Peak Performance

FTR

the Dependable link between Antenna and Receiver

HERE'S an Intelin* transmission line that's really designed to take plenty of punishment—to maintain peak performance of FM and television receivers under even the most rigorous conditions. Federal's K-1046 300-ohm line will withstand the scorching heat of the summer sun, the abrasion of wind-borne dust and dirt, freezing sleet and atmospheric moisture.

Its smooth solid polyethylene insulation resists water, acids, alkalies, oils and abrasion—won't embrittle or age in sunlight. It retains flexibility and demensional precision in hot or cold weather. Elliptical cross section enables it to withstand twisting—prevents accumulation of foreign matter and maintains stable capacity characteristics.

Stock up now to meet the increasing demand for new FM and TV installations. This 300-ohm line, as well as other Federal h-f cables—can be obtained through local distributors all over the country.

DATA FOR 300-OHM LINE

Type Number	Characteristic Impedance	Velocity of Propagation	Capacitance Per Ft.	Attenuation, Db per 100 Ft. Frequency in Megacycles				Physical Dimensions	
				1.0	1.7	3.0	100	Conductor Size	OD over Jacket
K-1046	300 ohms	81%	4.0 mmf	.38	.57	.85	2.0	7/# 30	.36"x .08"

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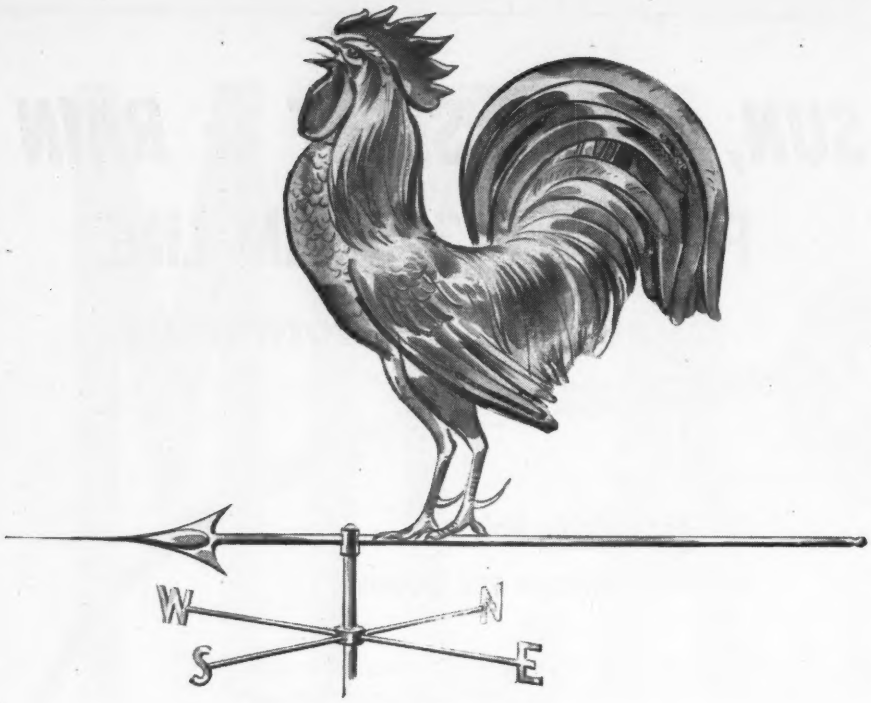

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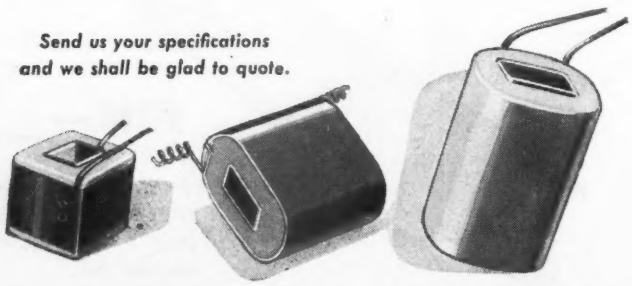

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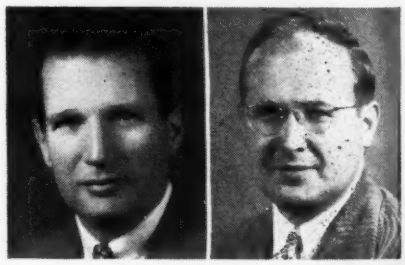
PERSONNEL

William Hatton has assumed responsibility for the coordination and development of manufacturing methods for the International Telephone and Telegraph Corp. in conjunction wtih his appointment as director of manufacture. During his 28 years with the system. Hatton, who is also the director of engineering for I. T. & T., has been instrumental in the development of communications systems in Europe, Australia, New Zealand, Java, Egypt, Argentina, Brazil and Peru.

Grenville R. Holden, vice-president of Sylvania Electric Products Inc., has been elected to the board of directors of Electronic Tubes Ltd., London, a radio manufacturing affiliate of Sylvania. As the representative of Sylvania abroad, his negotiations with foreign companies have resulted in the establishment of many new manufacturing facilities overseas. Holden who has been with Sylvania since 1943 will continue to assume his executive responsibilities in New York.



G. R. Holden Dr. C. K. Morehouse

Dr. Clarence K. Morehouse, formerly associated with the National Bureau of Standards as a dry cell battery specialist, will do research work on battery problems for the Winchester Repeating Arms Co. and Bond Electric Corp. Div. of Olin Industries Inc.

Willy Dumke has been elected a vice-president of Zenith Radio Corp., Chicago. He will have charge of production of speakers, transformers and hearing aids.

Dr. Leo L. Beranek has become associated with General Radio Co., Cambridge, Mass., as a consultant on acoustical problems and the design of acoustical measuring equipment.

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You Expect More and Get More From FP CAPACITORS

Exactly ten years have elapsed since the Mallory FP—first capacitor to use fabricated plate—was introduced. Today, as then, it is accepted as the standard of the industry: the standard for quality, dependability and ease of assembly.

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Today not only Motorola, but many other responsible manufacturers of radio, television and electronic equipment, choose Mallory FPs with safety and confidence. They expect more and get more from this famous capacitor.

Everything you want to know about Mallory electrolytic capacitors—types, sizes, characteristics — even data on test measurements and mounting hardware. Send for your free copy.

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Sound trucks with magnetic wire recorder-reproducers mean *better* announcements with *less* personnel! Here's a field that will net some aggressive engineer a neat piece of the profits in magnetic recording. Why don't you investigate? Look to the leader—Brush—for the finest in magnetic wire recording components!

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Constant plating thickness assures uniform signal.

Correct balance of magnetic properties assures good frequency response and high level.

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Of principal interest are their excellent electrical characteristics, extreme simplicity of design to avoid trouble, and the "hum-bucking" characteristics, which reduce the effect of extraneous magnetic fields. When required, the head cartridge alone (pole piece and coil unit) may be supplied for incorporation into manufacturers' own head structure.

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MAGNETIC RECORDING DIV. • ACOUSTIC PRODUCTS DIV.

INDUSTRIAL INSTRUMENTS DIV. • CRYSTAL DIVISION

He is associate professor of communications engineering and technical director of the acoustics laboratory of MIT.

William Clausen has been appointed manager of operations for the Farnsworth Television and Radio Corp. He will headquarter at Fort Wayne, Ind.

Chester I. Soucy a former theatre sound, audio and radio equipment engineer for the Northern Electric Co., Montreal, has been appointed chief engineer of Canadian Aviation Electronics Ltd., Quebec.

K. Blair Benson has been appointed senior engineer at United States Television Mfg. Corp. Formerly in charge of the design and development of projection television receivers at General Electric, he worked on electronic devices for military applications in addition to his activities in television receiver engineering.

Paul Weathers, for 16 years head of many engineering groups in sound and electronic equipment for RCA, has been appointed vice-president and chief engineer of Airdesign Inc., Upper Darby, Pa.

Robert M. Morris, manager of radio-recording for NBC in Washington, has accepted the chairmanship of the recording and reproducing standards executive committee of the NAB.

George F. Devine, employed by General Electric since 1935, has been appointed commercial engineer of the specialty divisions of the company's electronic department at Syracuse. He will be responsible for the performance, appearance specifications and quality control of the division's products.

RMA Adds Assistants

Two new staff assistants have been added to the Parts and Transmitter Divisions of RMA. They are Ralph M. Haarlander who will be assistant to S. P. Taylor, and James D. Secrist, RMA director of publications, who will be assistant to J. J. Kahn. Secrist has been with RMA since 1945.

Philco Patents Offered

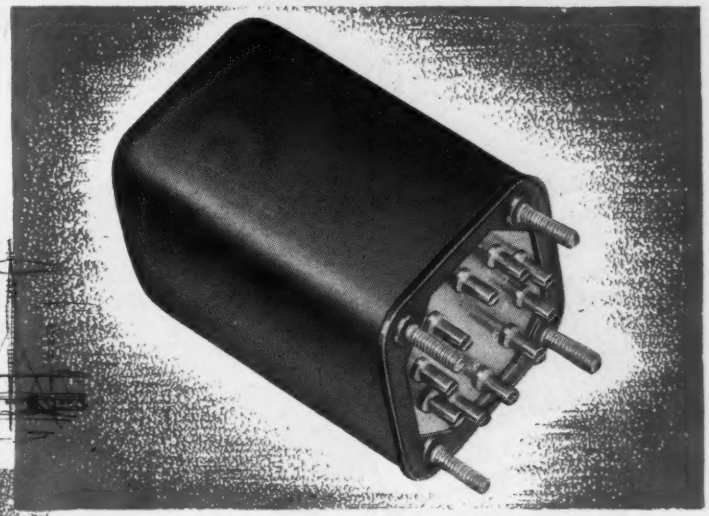
Philco Corp., Philadelphia, has opened its radio patent pool. All set manufacturers have been offered the privilege of operating under any or all of Philco's 700 patents covering sound receivers, electrical phonographs and television receivers. It is stated that RCA, GE and Westinghouse already have been licensed.

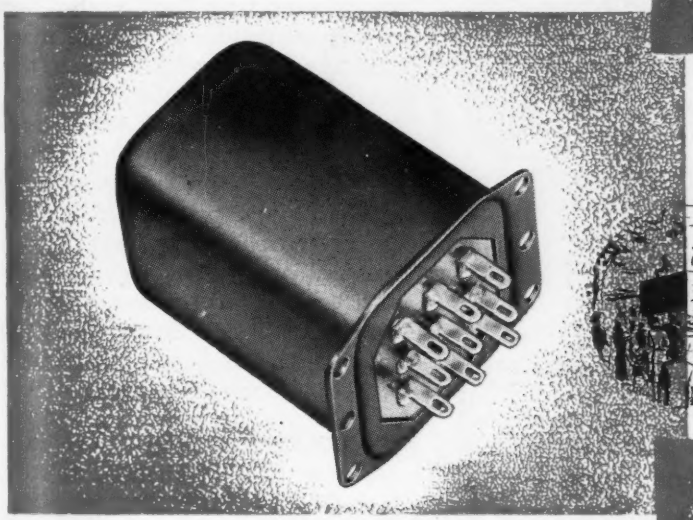
AUDIO TRANSFORMERS *for* UNIFORM RESPONSE LOW DISTORTION IN 3 FREQUENCY RANGES

Write for Catalog showing complete new stock line

Full Frequency Range

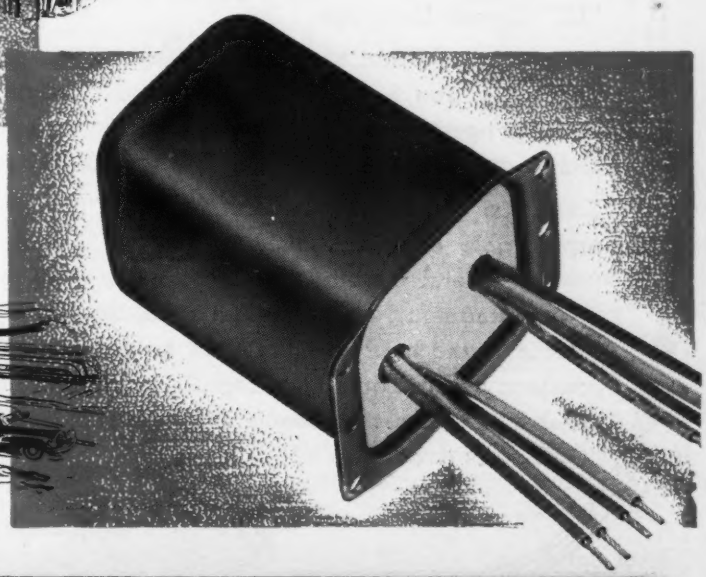
30 to 15,000 Cycles, provides uniform response over this entire band with ± ½ db up to 10 watts of audio power, within ± 1 db over 10 watts. Standard RMA impedances. Hum balancing coil structures and nickel alloy shielding. Included are Input, Output, Driver, and Modulation Transformers; Modulation Reactors. *Sealed in Steel* construction, stud mounting, with pin-type terminals.





Public Address Range

50 to 10,000 Cycles, frequency response within ± ½ db up to 10 watts of power, within ± 1db over 10 watts, throughout this range. Secondary impedances match 600 and 150-ohm lines, 16, 8 and 4-ohm reproducing systems. Listed are Driver and Output Transformers. *Sealed in Steel* construction, flange mounting, with solder lugs or wire leads.



Communications Range

200 to 3,500 Cycles, affords response with variations not exceeding ± 1 db over the range of voice frequencies. For use with 600 or 150-ohm lines. Input, Output, Driver and Modulation Transformers offered. *Sealed in Steel* construction, flange mounting, with wire leads or solder lugs.

CHICAGO TRANSFORMER

DIVISION OF ESSEX WIRE CORPORATION

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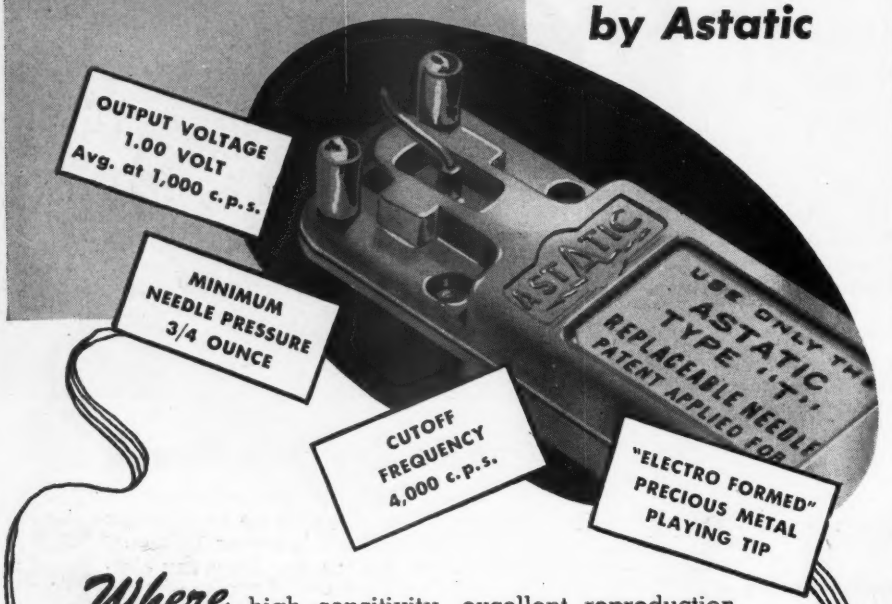
Low NEEDLE TALK CARTRIDGE INVADES Low PRICE FIELD

Exclusive New Type "LT" Cartridge Introduced by Astatic



Where high sensitivity, excellent reproduction, low needle noise or needle talk, and low needle pressure are required . . . and cost economy is an important factor . . . Astatic earnestly recommends this new Model "LT" Crystal Cartridge.

In the reproduction of high frequencies, this cartridge is noticeably free from disagreeable and annoying surface noise or needle talk . . . thereby providing increased tonal clarity and beauty for greater phonograph enjoyment.

The Type "T" Needle employed in the "LT" Cartridge is replaceable and is furnished with an "Electro Formed" precious metal playing tip. Matched to the Cartridge, to give permanent Needle performance, this new Type "T" Needle is the only one that can be used, thus assuring constancy of the quality of reproduction regardless of the number of times the Needle may be replaced. Special literature is available.

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ASTATIC CORPORATION
CONNEAUT OHIO
IN CANADA: CANADIAN ASTATIC LTD. TORONTO, ONTARIO

Astatic Crystal Devices Manufactured under Brush Development Co. patents.

FM Elects Dillard

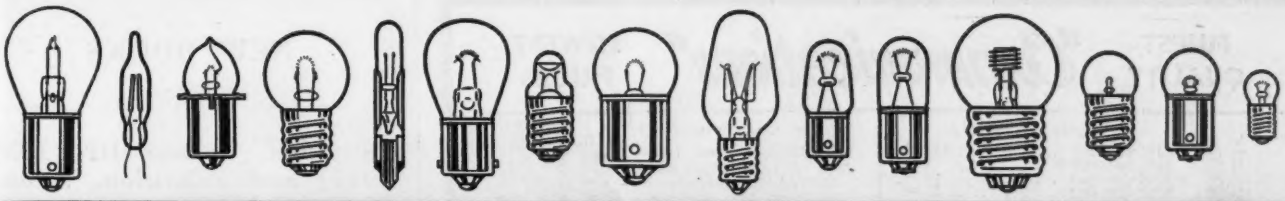
With something over 200 members and guests gathered in the Hotel Roosevelt, New York, during the two days, Sept. 12 and 13, Frequency Modulation Association staged its first annual convention since the birth of the organization nearly a year ago in Washington; most attention was paid to programing with one session devoted to engineering, highlighted by an FM demonstration put on by Major Edwin F. Armstrong, linking station WFMZ in Allentown and Alpine station W2XEA via Bethlehem station WGPA, providing an air line link between the two stations of 75 miles. Purpose of the demonstration was two-fold; to demonstrate the long-distance possibilities of direct transmission, and to show the quality inherent in FM even though it is transmitted over such long paths. For the demonstration the signal from WGPA was demodulated and the audio used to modulate W2XEA. The method, explained Armstrong, is not the best way but is justified as an expediency where small outlying stations cannot afford the use of microwave relay systems. At the business sessions of FMA, Everett L. Dillard, general manager of the Commercial Radio Equipment Co., Washington, was elected president succeeding Judge Hofheinz.

No Denny Successor Yet

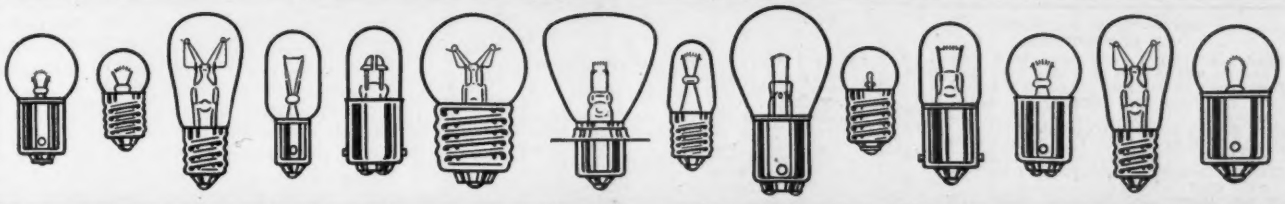
A new FCC chairman, to replace Charles R. Denny, who resigned October 1 to become NBC vice-president and general counsel, probably will not be designated for some time. Suggested as possibilities are former senators James M. Mead and Hugh B. Mitchell, Rep. Clarence F. Lea, former FCC general counsel Telford Taylor, now conducting the Nuremberg war criminal trials, former chief of Army Communications Services Brig. Gen. Frank E. Stoner.

More Tartak Speakers

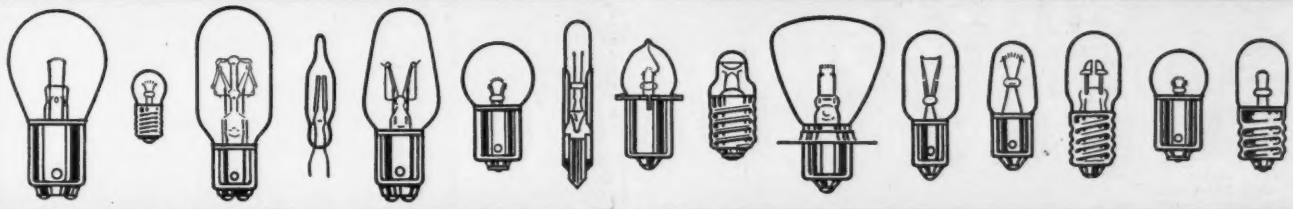
Paul H. Tartak has re-entered the speaker manufacturing field with a newly organized company styled Tartak Speakers, Inc. which will do business from 3120 East Pico boulevard, Los Angeles. Associated with him is Al Dresner who will be vice-president and general manager and who was formerly with Emerson. Company is making PM and electromagnetic speakers from 3-in to 12-in.



These little bulbs can make



a big difference in the success



# of your product

Whatever miniature lamps you need... incandescent or neon-glow... GENERAL ELECTRIC makes 'em all!

What can these little bulbs do for your product?

This brief check list of typical uses may suggest an idea to you:

Illuminated dials
Decorative light effects
Safety lighting
Pilot lights
Lighted toys
Inspection lights
Lighted signals
Numeral indicators
Night lights
Pinball games

WHAT progressive manufacturer doesn't ask himself almost daily—"How can I make my products more useful, more saleable, more profitable?" Many designers answer that problem by using inexpensive miniature G-E light bulbs to add safety, convenience and beauty to a wide variety of products.

Whatever job you may have for miniature bulbs, there is a G-E lamp that will suit your purpose exactly. General Electric's line is complete—all sizes and types—all wattages and voltages — filament and neon-glow lamps—for delicate service or heavy duty. And the high quality of every bulb is backed by G-E Lamp Research.

To make sure you get the right lamp for your application, entrust the selection to specialists who know all kinds of miniature lamps intimately. G-E Lamp engineers have the experience and practical knowledge to assist you. Call your nearby G-E Lamp office for full information. Ask for your copy of "Big Jobs for Small Bulbs".

General Electric Co., Lamp Dept., Nela Park, Cleveland 12, Ohio.

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FINEST QUALITY **"Communications"** LOWEST PRICES

MICROWAVE TUBES

3J31 (1 cm) $17.50
3J31 MAGNET 8.00
2J26 (10 cm) 25.00
2J32 (10 cm) 25.00
MAGNET for 2J32 ..... 10.00
2J38 (10 cm) with magnet 37.50
WE 700 A (L band) 45.00
WE 720 BY (S Band) 1000 KW 25.00
2K25-723 AB Klystron 7.75
QK 59, QK 60, QK 62 Tunable packaged Magnetrons, 10 cm .....ea. 45.00

MICROWAVE PLUMBING
10 CENTIMETER

Sand Load (Dummy Antenna) wave guide section with cooling fins, app 23" high $28.00
Rigid Coax Directional Coupler CU-90/UP 20 DB drop, has short right angle, about 8" 5.50
Coax Rotary Joint with mounting plate .. 8.00
Dipole Antenna in lucite ball, for use with parabolic 5.00
Flexible Coaxial Connector, rigid coax to rigid coax ⅞" diam. 2.50
10 CM Dipole and Reflector with type "N" Fitting 2.75
Waveguide to flexible coax coupler (RG 18 U), with flange. Gold plated. App 10" high 17.50
Rigid coax slotted section CU-60/AP .. 5.00
Stub-supported rigid coax, gold plated, 5' lengths. Per 5' length 5.00

3 CENTIMETER

Wave Guide Sections 2.5' long, silver plated with choke flange $5.75
Wave Guide 90 deg. bend E Plane 18" long 4.00
Wave Guide 90 deg. bend E plane with 20DB directional coupler 4.75
Wave Guide 18" long "S" curve 2.00
Rotary joint wave guide in/out choke to choke 6.00
Rotary Coupler choke input; round guide output 5.25
S-Curve Wave Guide 8" long cover to choke 2.50
Wave Guide 2.5' long, silver plate, 180 deg. bend choke to cover 5.95
Duplexer Section using 1B24 ..... 10.00
Wave Guide lengths per foot 1.50
Pick-up loop with adjustable tuning section, used in duplexer 1.50
3 CM Wavemeter Maquire 1539TFX 15.00
3 CM stabilizer cavity, tunable transmission type. Model 1551 (TFX 11 GA) .. 20.00

1.25 CENTIMETER

Wave Guide Section 1" cover to cover $2.00
T Section choke to cover 4.50
Mitred Elbow cover to cover 3.00
Mitred Elbow and "S" sections choke to cover 3.50
Flexible Section 1" long choke to choke ..3.00
Tunable Cavity with Coax input and output 6.00

Connectors

UG 21/U, Type "N", Male .....$ .85
UG 86/U, Gold Plated .....$ .95

MICROWAVE TEST EQUIPMENT

Wave guide experimental kit. Consists of: One direct-reading wavemeter, app 2600-3400 mc. (cavity type); One dummy load w/crystal probe. One line stretcher, full wave; two wave guide to RG 18/U coax couplers; two 1' sections w/flanges. Complete $250.00

10 CM ECHO BOX, complete with micrometer adjust cavity & resonance indicator. Type TS 238/GP. With calibration chart $105.00

10 CM WAVEMETER. Model "SL". Micrometer adjust cavity with microammeter resonance indicator. Includes 115 VAC operation converter section. In grey metal carrying case, complete with cables & spares. Made by Western Electric $135.00

W.E. I138A. Signal generator, 2700-2900 Mc. range. Lighthouse tube oscillator with attenuator & output meter. 115 VAC input, reg. Pwr. supply. With circuit diagram $50.00

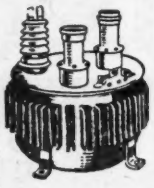
COAX CABLE

RG9U 51 ohm Silver Coated ....per ft $ .07½
RG8U 52 ohm .....per ft .04½
COAX Connectors Amphenol 10" Loss type 831R, 831AP .....ea .27
831F .....ea .45

THERMISTORS

D167332 Bead .....$ .95
D170396 Bead ..... .95
D168392 Button ..... .95

PULSE TRANSFORMERS
All Standard name Items



Type K2450A Will receive 13KV. 4 micro-second pulse on pri., secondary delivers 14KV Peak power out 100KW GE....$15.00

HI Volt. Magnetron Input transformer W.E. # D-166173 with cooling fins 12.00

U 4298E—Pri. 4 KV, 1 microsecond Sec. 16 KV, 16 amps. Fil. pri. 115v. 400 Cycle. Raytheon $15.00

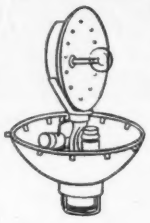
Hi Volt input pulse Transformer W.E. # D169271 ..... 9.95

Radar pulse Tformer K2731 Diameter App. 11" vertical cooling fins GE 19.50

Pulse, Input, line to magnetron. G.E. K2748A 12.00

Utah Pulse or Blocking Oscillator Transformer Freq limits 790-810 cy-3 windings turns ratio 1:1:1 Dimensions 1 13/16 x 1⅛ x 19/32 ..... .75

Fil. Trans.: Primary 117 volts, 50 to 62 cycles. Secondary two 5 volt windings at 5½ amps. 35,500 volts peak test ...$24.50



MICROWAVE ANTENNAS

Relay System Parabolic reflectors apprx. range: 2000 to 6000Mc. Dimensions 4. -5' x 3' New....$85.00

Dipole for above $5.00

TDY "Jam" Radar rotating antenna, 10cm, 30 deg. beam, 115V AC drive. New $100.00

SO Surface Search Radar rotating antenna, 10cm. 24" dish, complete with drive and selsyn motors. New $90.00
Used $45.00

3 CM. ANTENNA WITH DISH 14½", Cutler Feed horizontal and vertical scan with 28 V DC drive motor and drive mechanism. Complete. New $65.00

RADAR SETS

SO9-10CM. SURFACE SEARCH 4, 20 and 80 mile ranges; Raytheon, 250 KW peak power input to 2J27 magnetron. Complete set including: spare parts, tubes, wave guides and fittings.

SO13-IDENTICAL TO SO9. Complete set, used. Consists of: transmitter and receiver. PPI scope modulator, motor alternator, rectifier, power unit and new rotating antenna.

SN RADAR-GE, low power, 5 and 25 mile ranges. Uses GL464 as pulsed oscillator, 5" "A" scope, "S" band. Extremely compact; ideal for demonstration and laboratory work. 115V 60C operation.
Send for information.

10 Cm. RF Package. Consists of: SO Xmtr.-receiver using 2J27 magnetron oscillator, 250 KW peak input. 707-B receiver-mixer $150.00
Modulator-motor-alternater unit for above $75.00
Receiver rectifier power unit for above $25.00
Rotating antenna using dipole feed and parabolic reflector. New less hood $75.00
Used $45.00
RT39APG15 Transmitter-receiver. Lighthouse tube oscillator, .5 KW. App. 2700 Mc. operation. With lighthouse and TR tubes $100.00
Motor-Gen. Pu 43/A
Input: 24- 28 VDC @ 62 A. Output: 115 VAC, 7 A., 800 C.P.S. $15.00

CONDENSERS

All standard name items.

OILS

.25 mf. @ 20000 VDC $17.50
1.5 mf. @ 6000 VDC $12.50
10 mf. @ 25KV $75.00
.01 mf. @ 25KV $20.00

MICA

.08 mf. @ 1500 VDC $11.50
.03 mf. @ 2000 VDC, 55LA-50 .....$12.75
.045 mf. @ 2000 VDC $12.75
.00015 mf. @ 20 KV $25.00
.0001 mf. @ 20KV, 1970-404 ....$25.00
.002 mf. @ 15VK $20.00
.0051 mf. @ 15 KV $25.00
.006 mf. @ 10 KV $17.50
Isolating Capacitor, PL 1417. 106-110 mmf @ 10KV AC (peak). Each $3.50
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All merchandise guaranteed. Mail orders promptly filled. All prices, F.O.B. New York City. Send Money Order or Check. Shipping charges sent C.O.D.

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NEW BOOKS

Television, Volume III (1938-1941) and Television, Volume IV (1942-1946)

Edited by A. N. Goldsmith, A. F. Van Dyck, R. S. Burnap, E. T. Dickey, G. M. Baker. Published 1947 by RCA Laboratories Division, Princeton, N. J. Price each volume $2.50, cloth, or $1.50 paper.

The first two post-war volumes of the Technical Book Series published by *RCA Review*, these books contain a complete review of progress in television as reported by RCA engineers during the years stated. These papers were, for the most part, originally published in the *RCA Review, Proceedings of the I.R.E., Journal Society Motion Picture Engineers* and elsewhere. In Volume III, the papers covering the period 1938-1941, relate to pickup facilities, transmission, reception, and general progress of the art. Volume 4 (covering the war years) presents in addition to papers in the above categories, the subjects of color television and military television.

Fundamentals of Electricity and Magnetism

by L. S. Loeb (Prof. of Physics-Univ. of Calif.) Third Edition, published 1947, by John Wiley & Sons, New York. 669 pages — 275 illustrations. Price $6.

This is a textbook planned for a four credit course in electricity and magnetism from the basic principles to the more advanced electronic and nuclear concepts. It is aimed at a higher level than the usual first year texts, and requires a working knowledge of calculus. Earlier editions have shown the value of this method of presentation over some 20 years of use. This edition is revised and enlarged with new material, covering devices such as the betatron, synchrotron, synchrocyclotron, linear accelerator, and many of the newer UHF generating devices (klystrons, magnetrons, etc.). About 70 pages of problems are included, covering each chapter.

Proceedings of the National Electronics Conference, Vol. II (1946)

Published 1947 by the National Electronics Conference, Inc., Dr. R. E. Beam, sec., Northwestern University, Evanston, Ill. 741 pages $3.50.

This conference, the second of a series held each year in Chicago, attracted widespread attention by the scope and excellence of the papers presented. Reviews and abstracts of many of these papers appeared in the technical press at the time of the conference. Now, this printed record of 57 complete papers and nine abstracts is available primarily to members of the conference, but some extra copies are being offered to research workers, laboratory workers, and libraries.

The great diversity of subject matter makes a review of individual papers impossible here, however the

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TELE-TECH's leadership is based upon its unexcelled technical editorial coverage of the tele-communications field. During 1947 each issue averaged better than 70 pages of authoritative articles and other material of vital interest to its readers. ***No other magazine can match this record.***

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Superlative Reception!

Designed for use wherever high fidelity reception is required, the new postwar Meissner AM-FM Tuner and AM Tuner are now available for your most exacting requirements . . . Both of these new precision designed components cover the broadcast band from 527 to 1620 kcs. and the AM-FM Tuner also covers the FM band from 88 to 108 mcs. At 105-125 volts, 50-60 cycles, power consumption is 80 watts for the AM-FM Tuner and 60 watts for the AM Tuner. For further more complete information on these new quality units, write today to the address below;

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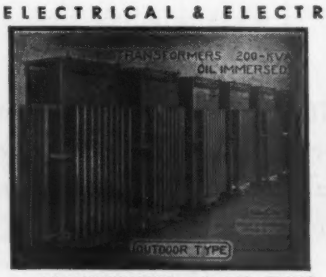

TRANSFORMERS OF ALL TYPES
Sizes from ¼ to 250 KVA
For furnaces, lighting, distribution, power, auto, phase changing, welding—air, oil, and water cooled, and special jobs.

24 HEAD RADIO TUBE EXHAUSTING MACHINE WITH BOMBARDER
Complete equipment for the manufacture of incandescent lamps, radio & electronic tubes.

SPOT WELDERS Sizes from ¼ to 250 KVA
We have a complete line of spot, butt, gun and arc welders.
EISLER ENGINEERING CO., INC., 778 So. 13th St., Newark 3, N. J.

NBC's TV Actors Get Radio Direction

NBC is to experiment with radio communication for use within a studio for the direction of actors in the production of television plays. FCC has issued a construction permit to cover an experimental class 2 station operating at low power at frequencies available in the band allocated for industrial, scientific and medical work.

book includes many topics relative to industrial electronics and all phases of the communication field. A few copies of Vol. I of the proceedings of the first conference are also available ($3).

Klystron Tubes

By A. E. Harrison. Published 1947 by McGraw Hill Book Co., 271 pages, 141 illustrations and 13 charts. Price $3.50.

An extensive interpretation of the behavior of Klystron tubes, starting by comparing their differences with older types of tubes. The basic characteristics of velocity modulation tubes is thoroughly presented. Practical data on the operation of Klystron tubes, power supply considerations, modulation methods of each type, timers and measurement methods are included. Much useful design material is presented on cavity resonators, bunching theory, Klystron amplifiers and frequency multipliers, reflection and reflex operations and on multiple resonator tubes.

Concise Chemical and Technical Dictionary

Edited by H. Bennet, Technical Director, Glyco Products Co., Inc., published by the Chemical Publishing Company, Inc., Brooklyn, N. Y. 1947, 1055 pages, $10.00.

About 50,000 terms are listed in this extensive volume, each followed by a few descriptive and explaining words. The dictionary is mostly concerned with chemical terminology, but expressions used in radio and television and in electrical and mechanical engineering are included. It contains information on elements and chemical compounds, on a large variety of chemicals, raw materials and finished products, apparatus, and manufacturing processes. The book includes trade name or proprietary products in the synthetic resin, plastic. metal, rubber, textile, food, pharmaceutical, paint and varnish fields.

A Russian-English Technical and Chemical Dictionary

By Ludmilla Ignatiev Callaham, Technical Translator, published by John Wiley & Sons, Inc., New York 16, N. Y., 197, 794 pages, $10.

Callaham's Russian-English Technical and Chemical Dictionary is a reference to 80,000 terms, intended by the author to be used chiefly by research and industrial workers. Designed to be used without the aid of additional dictionaries, it includes

all types of words likely to appear in technical articles. The dictionary covers organic and inorganic chemistry, chemical technology and mineralogy; metallurgy, mining, geology, engineering, physics, botany, pharmacy, machinery, mechanics; it includes the more common terms in agriculture, entomology, medicine, aeronautics, meteorology and military science. Special effort has been made to include terms of particular value to industrial technologists. Many such terms are new in technical terminology, and therefore difficult to find—as are numerous mechanical and machine terms also given.

Each technical Russian term has been checked in several Soviet sources. Every available English-Russian, German - Russian, and straight Russian technical dictionary has been examined word by word for the compilation of terms. English equivalents in chemical engineering and technology have been checked by a practicing engineer. In addition, the book contains many words never before compiled in a dictionary.

New Scott Company

A new company to manufacture his dynamic noise suppressor has been formed by Hermon Hosmer Scott. He will be president and director of engineering of Hermon Hosmer Scott, Inc., with a factory at 385 Putnam avenue, Cambridge, Mass. Associated with him are Henry Chrystie (vice-president) who was associated with Scott at General Radio Co. and later at Technology Instrument Corp., and Ralph Glover (consulting engineer). In addition to the noise suppressor the company will produce audio frequency equipment and measuring instruments.

DuMont Consolidates Television at Clifton

All departments of the television transmitting equipment division of the Allen B. DuMont Labs., Inc., have been consolidated under one roof in new headquarters at 42 Harding avenue, Clifton, N. J. The sales department remains at 515 Madison avenue, New York.

Haydon Moves

Haydon Mfg. Co., which for some time has carried on its operations from its Forestville, Conn., factory, on October 1 moved to a new location in Torrington, Conn. The new building will provide for expanded production.

Meck Uses Fremodyne

The new Hazeltine FM detector, styled Fremodyne, is a combination superregenerator and superheterodyne employing the fundamental principle of an off-tuned resonant circuit to convert FM to audio. Meck Industries incorpor-

G-E Variable Reluctance Pickup

CHECK these characteristics of the G-E Variable Reluctance Pickup against your present reproducer head. Make your own exacting tests. Prove to yourself that this pickup will improve the reproduction quality given by your own phonographs.

The G-E Variable Reluctance Pickup has:

- No resonant peaks.
- Wide frequency response—essentially flat from 30 to 8000 cycles.
- High compliance of the stylus—hence more faithful reproduction and exceptionally low record wear.
- Self protecting genuine sapphire stylus.
- Virtual freedom from "needle talk".
- Practical insensitivity to vertical vibration—the source of surface noise.
- Stability under humidity, heat and cold.

We are equipped to make prompt delivery to meet your production schedules. For complete information on this finer pick-up write *General Electric Company, Electronics Park, Syracuse, N. Y.*

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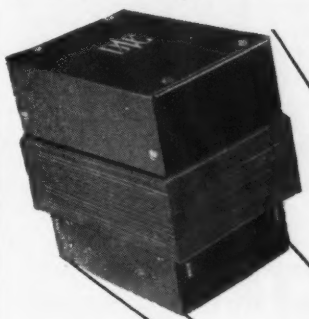

Plan for performance perfection. For transformers and electrical coil windings of superior quality and production, use Dinion Transformers and Coils. Manufactured to specification or designed to meet particular requirements. Special or mass production.

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- Radio
- Instrument
- Television
- Electronic and Industrial Applications
- Electrical Coil Windings

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SUPERIOR ELECTRIC CO.

PROTECTS THEIR AUTOMATIC VOLTAGE REGULATORS WITH

HEINEMANN

MAGNETIC CIRCUIT BREAKERS

In a Bulletin advertising the high quality equipment shown at the left, the manufacturer states that since the first STABILINE Voltage Regulator, Type EM was built, many improvements have been added, among them "a fast-trip magnetic type circuit breaker to perform two functions. It eliminates the task of replacing fuses when the current is overloaded, and also acts as an ON-OFF switch." This emphasizes the *convenience* of the HEINEMANN CIRCUIT BREAKER.

POSITIVE Yet FLEXIBLE Protection

In the above equipment the circuit Breaker is installed in the brush lead of the Powerstat variable voltage transformer. When the load exceeds the current rating of each individual transformer, the Circuit Breaker opens thus eliminating any chance of injury to any part of the equipment.

These breakers are *instantaneous* on short circuit, but a magnetic-hydraulic time delay mechanism allows passage of slight, temporary overload. If this overload continues beyond the time-delay limit, the breaker trips. Magnetic blowout provides high and fast interrupting capacity.

***Your* equipment can be equally well protected by the installation of**

HEINEMANN MAGNETIC
CIRCUIT BREAKERS
Write for further information.

HEINEMANN ELECTRIC CO.

149 PLUM STREET — TRENTON, N. J.

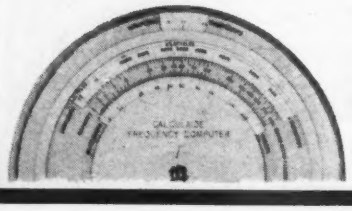
EST. HECO 1888

***Speed up with new* FREQUENCY COMPUTER**

"Calculaide" quickly solves problems involving frequency, inductance and capacity. In one setting, the natural frequency and wave length of an LC circuit can be correlated with coil dimensions and capacity value. Covers range from smallest single-layer coil to large Xmitting coil. F range — 400kc to 150mc; C range — 3 —1,000 mfd; L — .1 to 1,500 mh. Made of durable Vinylite plastic 6¼" dia.

Price **$2.85**

Write for quantity disc.



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ates Fremodyne in its tuner using a 6F8 double-triode or equivalent and a suitable rectifier. The heart of the new circuit including regeneration and mixing, is the single stage using a double-triode. An IF of 21.7 mc is used and the sensitivity is reported to be 10 microvolts. A line cord antenna is available with provision for connecting an outside dipole.

N. Y.-Schenectady Relay

(*Continued from page* 61)

Both relay stations in the system are unattended and operate automatically. Receivers are constantly turned on. Reception of a signal operates a relay which energizes the relay transmitter at the first station and the process is repeated at each of the others in turn. Transmitters are rated at between 5 and 10 watts output. It is estimated that the gain in the relay approximates 1400^2 times the input at the receivers. As received at Schenectady and rebroadcast by WRGB, pictures are excellent in quality, brilliance and contrast being practically indistinguishable from those broadcast and received locally. It is stated that the relay may eventually be extended to Syracuse.

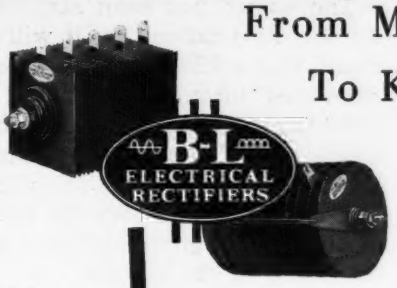
Coincident with the inauguration, of the relay service, NBC's vice-president William S. Hedges let it be known that early this fall WBAL-TV in Baltimore is to be added to the network and within the next several months service will be extended to Boston. He reported further that work has already started on an NBC transmitter to be located atop Mount Wilson to serve the Los Angeles area; construction permits are held for NBC owned stations in Chicago and Cleveland and plans are going forward for intermediate stations between New York and Chicago and beyond.

Ratio Dectector

(*Continued from page* 41)

back through the tube V_2 is degeneratively applied to an unbypassed cathode resistor R_1 of the tube V_1. The tube V_3 is arranged so that the signal at "input 2" effectively controls its gain linearly over a narrow range by means of an electrode intermediate to the control grid and the plate.

From Milliwatts To Kilowatts



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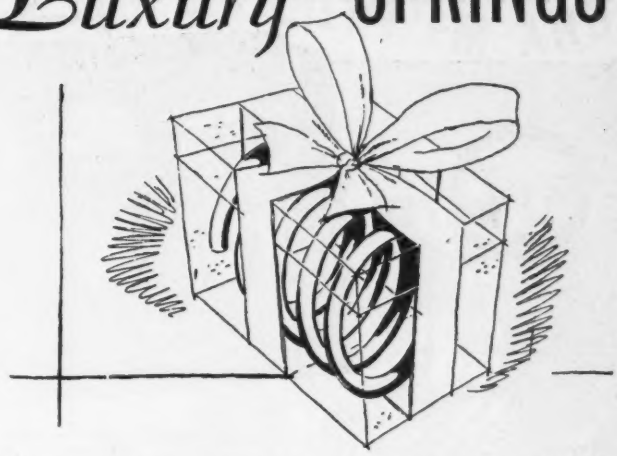

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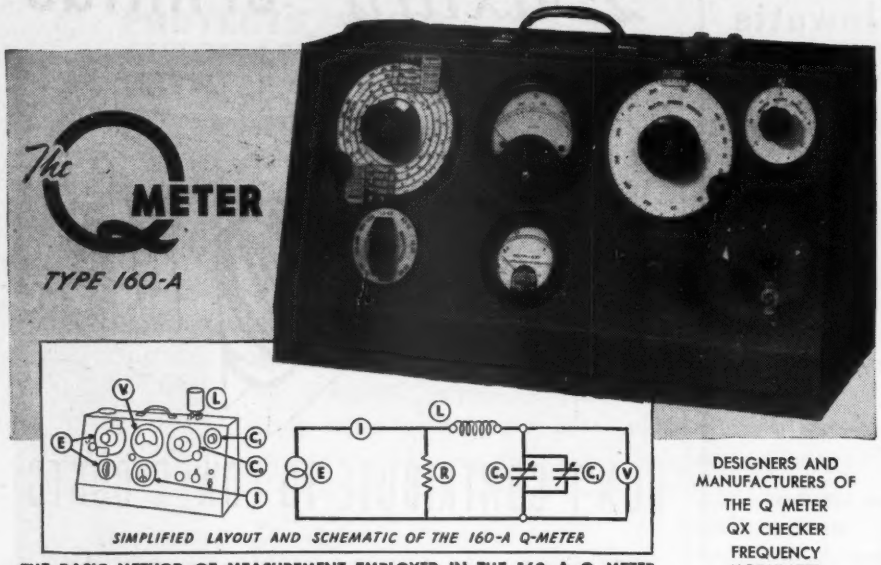

SIMPLIFIED LAYOUT AND SCHEMATIC OF THE 160-A Q-METER

THE BASIC METHOD OF MEASUREMENT EMPLOYED IN THE 160-A Q-METER An R.F. oscillator (E) supplies a heavy current (I) to a low resistance load (R), which is accurately known. The calibrated voltage across the load resistance (R) is coupled to a series circuit consisting of the inductance under test (L) and a calibrated variable air capacitor (C_0) having a vernier section (C_1). When this series circuit is tuned to resonance by means of capacitor (C_0+C_1), the "Q" of (L) is indicated directly by the V.T. Voltmeter (V). Variations of this method are used to measure inductance, capacitance and resistance. *Oscillator Frequency Range:* 50 kc. to 75 mc. in 8 ranges. *Oscillator Frequency Accuracy:* ±1%, 50 kc.—50 mc. *Q-Measurement Range:* Directly calibrated in Q, 20-250. Multiplier extends Q range to 625. *Capacitance Range:* Main section (C_0) 30-450 mmf. Vernier section (C_1) +3 mmf, zero, —3 mmf.

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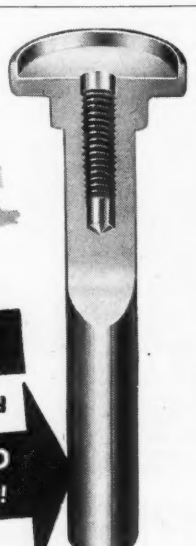

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The circuit has been simplified for this illustration, but it will be found that a 6SK7 with its screen connected through 1 megohm to the +B terminal, and its suppressor connected to the terminal "input 2" has just the desired amplification characteristics over the range of frequencies and amplitudes encountered in FM systems.

Fig. 3 illustrates the manner of connecting a conventional Foster-Seeley discriminator to the Fig. 2 system when it is to be used as a ratio detector. Any of the many other familiar types of discriminator may be used, provided only that there must be available a pair of signal voltages the ratio of which is the desired modulation signal.

It has been found in actual tests that the distortion introduced by this detector is very nearly proportional to the ratio $(1-\beta)$ to unity. Thus by providing a large ratio of gain through V_2 in the degenerative direction to the forward gain of V_1 this distortion may be minimized.

Noise Generator

(*Continued from page* 30)

two single tuned stages are staggered as shown in Fig. 8, the overall response varies with frequency in the same manner as one double tuned stage with both windings adjusted to the same frequency. In fact, the parameter "d" exactly replaces the coefficient of coupling K. The response of the two stages may then be indicated by

$$R = A\frac{1}{1-(S^2-d^2)Q^2+j\,2SQ} \qquad (1)$$

where A is a constant determining the absolute gain. It is seen from equation (1) that at $f=f_o$ $(S=0)$ there is zero phase shift, and when

$$1-(S^2-d^2)Q^2=0$$

the real part disappears and there is a 90° phase shift. Thus when

$$S=\frac{\pm\sqrt{1+d^2Q^2}}{Q}$$

a lead or lag of 90° is obtained, and a total range of 180° is available. It will be noted that the variation is obtained by shifting f_o which is accomplished by tuning f_1 and f_2 with a fixed spacing, 2D, between them.

By making $dQ=1$, the equivalent of critical coupling, the phase

variation is made linear, and the overall gain is down 3 db at the 90° phase shift points.

An additional fixed 180° phase shift is obtained in T6-7-8. Output is taken from both plate and cathode of T6 and applied to T7-8. Either section of T7-8 may be cut off by means of switch S_1, thus providing output with a choice of two opposite polarities from the cathode of T7-8.

The noise synthesizing channel consists of tubes T1-2-3. From the basic rf generator, signal is applied through the buffer amplifier T3 to the grid of T2, which operates as a gated amplifier. Gating is accomplished by returning the grid of T_2 to a high negative bias potential, but periodically raising the grid to zero bias with the tips of a gating pulse. The latter is obtained by differentiating the sync pulse from a conventional synchoscope and applying it through the cathode follower T_1 to the grid return of T_2. The period for which T_2 acts as an rf amplifier is adjusted to be one half microsecond, and the repetition rate of the noise bursts is that of the sync pulse. The ouputs from T_2 (noise burst) and T_7 and T_8 (desired signal) are then added in the resistive mixing pad. The latter is designed to work into a 70 ohm receiver input and to look like 70 ohms in all directions.

In practice, the output point is connected to the antenna input of the receiver to be tested, and signal at any desired level applied to the rf input. The trigger input pulse is then turned on, and the audio output of the receiver measured, or observed on an oscilloscope, with various phase adjustments. The oscilloscope sweep circuit may be synchronized with the trigger pulse, allowing excellent observation of the "pop" or "click" wave form.

As might be expected, when the receiver is nearly center tuned the phase must be adjusted almost to phase opposition to obtain a loud response, or "pop". When the receiver is greatly detuned so that the rate of rotation of the vector OS is high, the noise burst timing, or phase, has a wide range of values over which OS will pass through phase opposition while the noise bust signal is dominant. Thus "pops" are developed

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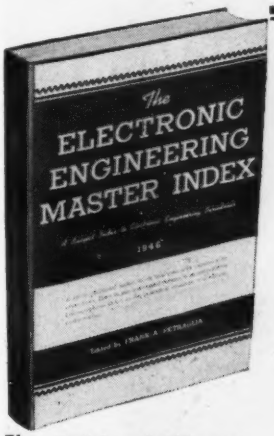

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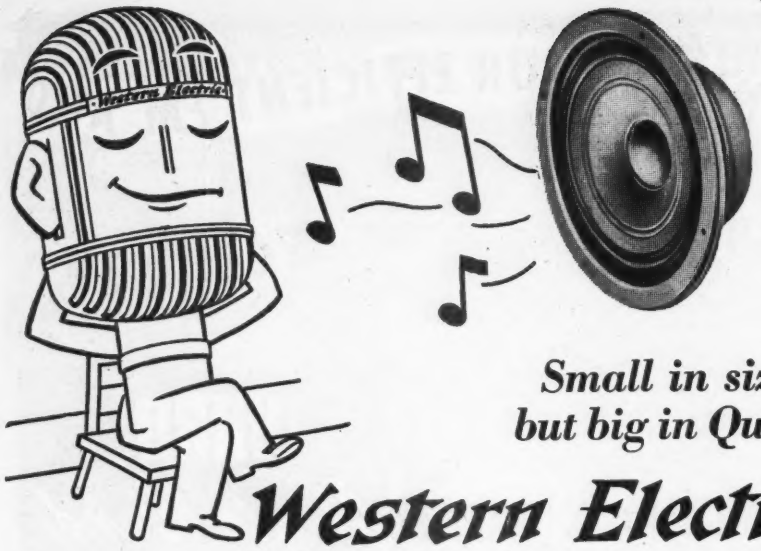

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over a greater percentage of the total phase range possible.

Credit should be acknowledged to K. H. Emerson for the original conception and to Albert Alter and Eric Elnegaard for their important contributions to the design and development of the equipment.

Tricon Air System

(*Continued from page* 40)

but if a scanning method (like that in television) were used, the need of a multiplicity of lamp connecting wires could be reduced to a practical number. There was no reason why three or more of these control boards could not be located at one place, a master control room, because the impulses feeding them can be transmitted over ordinary telephone wires.

Dr. Alvarez mentioned a rather simple method of setting the modulation phase delay at the transmitting stations in order to produce an airlane of the desired pattern or location. The slave station would radiate a 3 mc sine wave. An electronic counter could be used to count the positive peaks, and when the correct number was received the counter would so indicate. From this data a chart could be arranged to give the needed phase shift.

PROJECTED ACCOMPLISHMENTS OF THE TRICON SYSTEM. In brief, these are said to be: (a) accuracy; distance along the track $\pm 1/4$ mile, transverse ± 500 feet within 60 miles; (b) computors are on the ground; (c) automatic block system; (d) complexity less than other systems giving similar performance. (Other advantages have been mentioned in an earlier paragraph.)

Visualization of Equipment

Engineers have estimated that the master transmitting station would require 30-35 vacuum tubes; a "slave" station about 45-48 tubes; and the receiver and transmitter for the annunciator system about 50 tubes. In the plane, the pulse navigation receiver would be one rack weighing 35 lb., containing 35 tubes; annunciator and identification transmitter, 25-27 tubes, weight 30 lb.; and for traffic control the

equipment, with 20 tubes, would weigh about 18 lb.

As the reader has surmised it was the reaction to this newly proposed system that was desired from the group of Army, Navy and civilian air navigation experts who listened to the description of the Tricon system. The questions and comments at the conclusion of the talk were numerous and pertinent. They were answered clearly and frankly. Naturally the listeners had some difficulty in evaluating such a many-sided electronic system when presented rapidly in the form of a blackboard talk without opportunity for previous study.

The operations experts preferred to withhold their comments until they had seen at least an experimental test of the system. And it is hoped that Tricon will reach this stage without delay, for then it may at once be evident that there has been born an air navigation system that will be as useful to planes in the air as the Ground Control Approach system is proving to be to planes in the process of landing safely.

Feedback Head

(*Continued from page* 49)

when operating into a reactive load impedance is like trying to force a fish to act like a fowl. In this case though, the tubes are enclosed in a *current* feedback loop which instead helps the "fish" to be a good fish. Current feedback and this type of tube fit together hand and glove. The output transformer T3 must be well interleaved and have a good phase shift characteristic, since it is included in the secondary or "current" feedback loop.

The potentiometer A is for the purpose of balancing the two push-pull sides of the amplifier with respect to ground for the current feedback loop. Similarly, the adjustable resistors B and C are provided to permit the feedback voltages produced from the two feedback windings in the cutter to be precisely balanced in amplitude. These balancing operations become extremely important when large total amounts of gain-loss feedback are used over a push-pull amplifier, since a slight unbalance from side to side in the feedback

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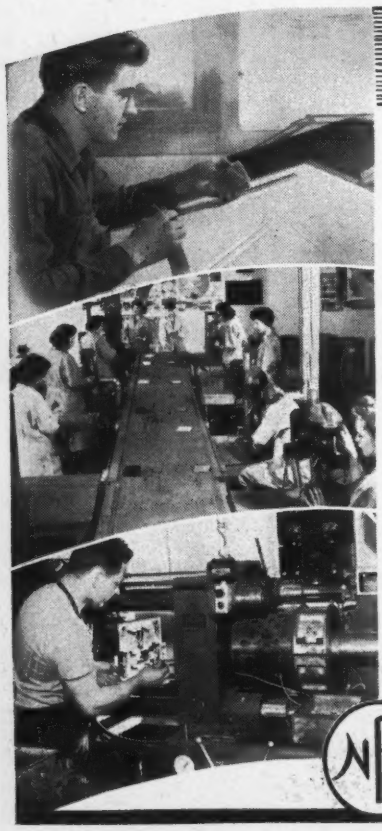

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network might wreak havoc on the overload point.

For the same reason, the signal input at the feedback re-introduction point (V3) must also be precisely balanced about ground at all frequencies, and therefore T2 is a precision coil of "hum-bucking" construction not only in order to buck hum but also to provide a balanced distributed capacitance on each side of the secondary center tap. The balance adjustments (B C A) are all easily made by means of minimizing the voltage observed across the common cathode resistor of the output tubes when steady 1,000 cycle tone is applied. The setting of A is performed with the outside feedback loop removed (B and C shorted).

The number of decibels of outside loop feedback can be changed within limits by the loading effect of adjustable resistors B and C on the cutter feedback coils. Retard coil L3 is provided in order to avoid wasting output power at low frequencies in resistor A, since the load impedance at low frequencies is essentially the dc resistance of the cutter driving coil (65 ohms). At low frequencies the inside loop is not necessary for stability, so this is permissible.

Whenever two iron core transformers are enclosed in a feedback loop special precautions must be taken to avoid tendencies toward singing or instabilities which occur far outside the useful transmission range of the equipment. Circuit elements which fall into the category of anti-sing components include C5 and C6, R24 and R25, C14 and D, B and C, and the stray capacitances present in the power tetrode grid input circuits. Generally speaking, leaving the common cathode resistor unbypassed also contributes to this stability. The resistor D is not permitted by C14 to dissipate any substantial portion of the amplifier output power until the useful frequency range of the equipment has been passed.

Most 6L6 casualties are due to violent attacks of parasites which destroy the vacuum and pave the way for other diseases such as high cathode current, reverse grid current and positive ion bombardment of the electrodes. Resistors R15, R16, R17, R18 (metallized), R20,

R21, R22, R23 (wire wound) are in the classification of parasitic suppressors, and when attached directly at the tube terminals are effective in this capacity and thus in assisting the beam tube in living a long healthy life.

Cutter Refinements

If we use a high saturation flux density pole piece material such as Permendur, we cannot take advantage of its excellent properties unless the dc (magnet) flux density is sufficient to cause the pole pieces and armature to operate about half-way up the useful portion of the Permendur BH curve (Fig. 5, point X). In order to do this, a surprisingly large amount of magnet may be coupled. This necessity for a high magnet volume permits us to take advantage of the situation and enjoy the luxury of a split-magnet design.

One magnet is coupled in at points G and H (Fig. 2), another at J and K. One outstanding advantage of this feature lies in the fact that little or no dc flux need flow in the Permendur sections around which are wound the feedback coils. This tends to diminish somewhat the magnetic mutual leakage coupling between driving and feedback coils, and lessens any possible danger of saturation-effects at E and F.

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Feedback coils at E and F are well embedded in the pole pieces, and designed so that nearly 90% of their enclosed area is occupied by Permendur. This results in only a very small portion of their developed voltage being due to leakage flux which is not indigenous to the permeable core. Thus the dilution of feedback $N\frac{d\phi}{dt}$ — information with leakage $N\frac{d\phi}{dt}$ — is minimized.

One pole piece feedback coil is connected in one side of the push-pull amplifier for feedback, the other coil in the other side. This state of affairs results in an interesting circumstance:

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FACTORIES (light assembly) SHIPPING— RECEIVING	CR 1BB OR SMN WITH MAH	Paging and announcing Same as above, but distribution 360°	1-3 watts per 1000 sq ft	1-2
	RCR			
	PN OR LH WITH SAH	Voice and music. Same as above, but distribution 360°		
	RPH WITH SAN OR RPB 12			

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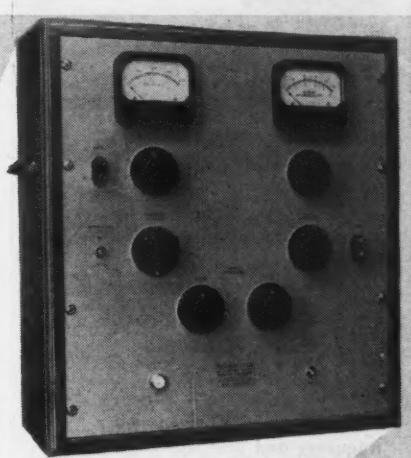

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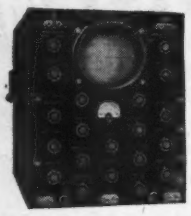
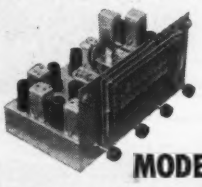


Versatile, Precision OSCILLOSCOPE MODEL OL-15

This is a highly flexible instrument particularly adaptable for production testing or research work in television, radar, facsimile work, and radio-frequency equipment.



MODEL RJ-12 FM-AM TUNER

An easy-to-install highly-sensitive tuner that provides distortion-free reception on FM and quality reception on AM. Tuning eye shows correct tuning. One antenna serves both FM and AM. Many other features.

WWV FREQUENCY CALIBRATOR

Full, accurate use of station WWV, the world's finest primary frequency and time standard, is obtained from the Browning Model RH-10 Standard Frequency Calibrator.

WRITE FOR LITERATURE

OTHER EQUIPMENT manufactured by Browning Laboratories includes an accurate frequency meter and ECO Model MJ-9, for operating in the Ham bands, and a frequency meter (Model S-4) especially designed for checking mobile transmitters.

BROWNING LABORATORIES, INC.
WINCHESTER, MASS.

in dimension of the gaps due to assembly of the cutter or maladjustment of the centering springs.

This last action satisfies one of the prime theoretical requirements of the four air-gap differential-resultant-force structure and helps considerably toward the establishing of a high-performing system, around which it is well worth while to draw a stabilizing feedback loop.

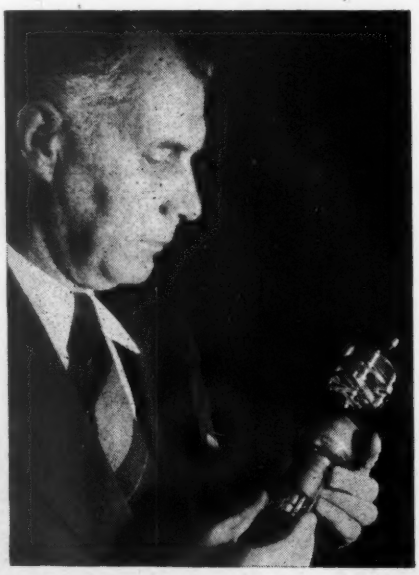
Pulse Modulation

(*Continued from page* 31)

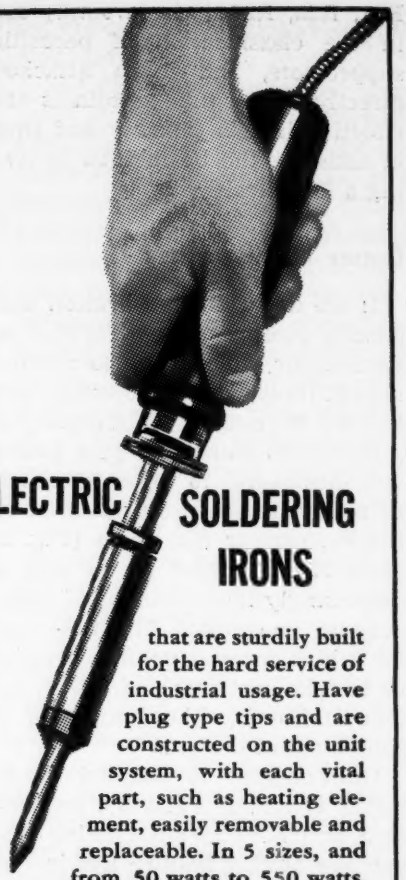
The collector plate in this tube, beyond the perforated grid in the path of the electron ray, receives these pulses and serves to modulate the transmission system.

In the transmission of higher quality speech and music, two adjacent 7-digit channels were combined so that a 10 (or more) digit code could be handled. A high quality musical program with a sampling rate of 24,000 per second, with each amplitude sample representable at more than 1000 levels by code symbols, was arranged during the demonstration. This test showed that this method of modulation was capable of handling this program in a manner that was in every way equal to direct modulation over the specially prepared high quality lines.

The new technic is expected to find use on broadband transmission hook-ups, including mic-



Holding the new tube, to show its relative size, is Bell Lab. engineer R. W. Sears who developed it for PCM



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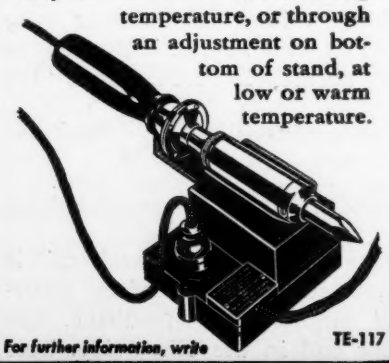
that are sturdily built for the hard service of industrial usage. Have plug type tips and are constructed on the unit system, with each vital part, such as heating element, easily removable and replaceable. In 5 sizes, and from 50 watts to 550 watts.

American Beauty

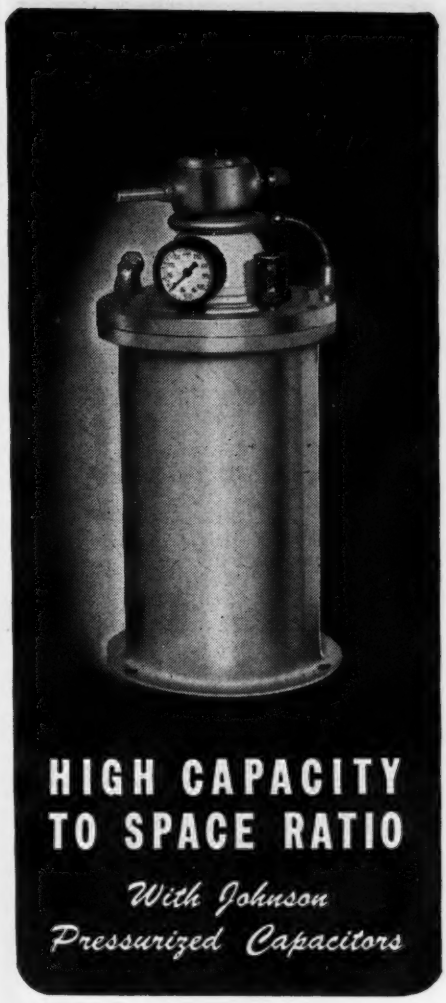
TEMPERATURE REGULATING STAND

This is a thermostatically controlled device for the regulation of the temperature of an electric soldering iron. When placed on and connected to this stand, iron may be maintained at working temperature, or through an adjustment on bottom of stand, at low or warm temperature.



For further information, write TE-117

AMERICAN ELECTRICAL HEATER COMPANY
DETROIT 2, MICHIGAN
established 1894



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JOHNSON Pressurized Capacitors are so carefully engineered that they provide the desired capacity and voltage rating with minimum pressure and condenser height. Because of their efficient electrical and mechanical design, they also provide the utmost in stable operating conditions.

Available as "standard" are variable, fixed and fixed-variable units — in a wide variety of capacitance and current rating. In addition, JOHNSON can build any pressure condenser to individual specifications.

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rowave radio relay systems, such as that now being installed to link New York and Boston. Its greatest feature stems from the possibility of reconstructing the pulses (which are in any case just "on-off" signals) at each repeater or relay point to reestablish their original sharpness. In this way the gradual debasement of the quality as a signal progresses through the repeater points is avoided.

NAB Conference

(*Continued from page* 59)

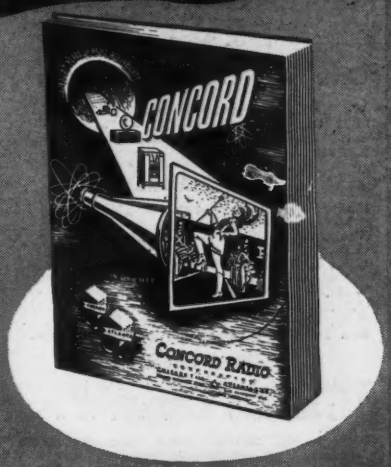
(7) Is this determined from factory measurements of selected receivers or from receivers that have been in use for six months, a year or how long?
(8) What are the propagation characteristics of the ground wave band of the skywave?
(9) How do these vary in different areas at different time on different frequencies?
(10) What are the frequencies and powers best suited for the various classes?
(11) If the power of one class is raised horizontally what engineering or economic effects does it have on the others?
(12) Under what conditions should daytime or limited time stations be permitted?
(13) When does daytime begin and end from the standpoint of radio propagation?

An antenna for circular polarization which combines a vertical dipole and a slot type radiator was displayed and described by Carl Smith, United Broadcasting Co., Cleveland, Ohio. This design, already tested and proved, is Smith's eighth model, and is distinguished by the fact that individual units may be stacked for greater gain. The unit on demonstration was a 4-bay design for operation at 800 mc.

The illustration indicates how the new antenna evolved from the vertical dipole and a slot antenna. Currents in the slot antenna flow horizontally and account for the horizontal component. The vertical dipoles supply the vertical polarization. A 90-degree phase shift is obtained by a quarter-wave section providing quadrature currents for the vertical and horizontal elements. For use in FM broadcast band each pipe-section will be ½ wavelength high. The physical dimensions are 54 in. high and 16 in. in diameter for 100 mc.

The feeders consist of two transmission lines which run coaxially up the center of the supporting structure. The slot mid-point of each unit is paralleled to one line, and the dipole mid-point to the other. Quarter-wave bazooka sections at the bottom and top of the array serve to prevent stand-

Just Out!



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0-1 Amp. RF. Built-in thermocouple. GE type DN-56. 2½" round. X168M—Each . $1.95
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X156M	10	450	27c	X161M	50-30	150	29c
X157M	10-10	450	47c	X162M	16	500	39c
X158M	16	450	29c	X163M	100	50	15c
X159M	20	150	22c	X164M	100-100 50-20	50	19c

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Roller Smith miniature, 1½" square, 1.25 MA movement.
Simpson 26, 3½" rd O-15 MA.
G.E., DO-41, 3½", rd, 1 MA black scale.
G.E., DW-41, 2½", rd 1 MA full sc, calibrated 140 D.C. V & 500 MA.
W.H., NX-35, 200 MA, 3½", rd fl bake case.
G.E., DO-53, 20 MA, 3" square fl bake case.
G.E., DO-41, 30 MA, 3½" rd fl bake case.
Sun 3AP259, 1 MA, 3½", rd fl bake case.

D.C. AMMETERS

Triplett 0321-T, 15 A, 3½", rd fl bake case.
G.E., DO-41, 200 A, comp with ext 50 MV (Aircraft style) shunt, 3½", rd fl bake case.
Weston 506, 200 A, comp with ext 50 MV shunt, 2½", rd fl bake case.
U.S. Gauge 2" rd clamp mtd metal case, Auto type, 30-0-30 Amps D.C. black scale.
G.E., DW-51, 30-0-30 A 2½", rd fl metal case.
Beede, 30-0-30 A, 2½", rd fl metal case.
W.H., F-1 (NX-33, 150 A, black sc, comp with ext 50 MV (Aircraft style) shunt, 2½" rd fl bake case.

A.C. AMMETERS

Triplett 331-J.P., 30 A, 3½", rd fl bake case.

RADIO FREQUENCY AMMETERS

G.E., DW-41, 6A, black scale, 2½", rd fl bake case.
G.E., DW-52, 1.5 A, black scale, 2½", rd fl metal case.
W.H., NT-35, 3 A, 3½", rd fl bake case.

D.C. MICROAMMETERS

G.E., DO-41, 200 microampere mvt, Knife edge pointer, sc mkd "Set Carrier" supp with paper V.O.M.A. sc, 3½", rd fl bake case.
G.E., DO-53, 500 ua mvt, sc cal 0-15 KV DC supp with paper V.O.M.A. sc, 3½", sq fl bake case.

A.C. VOLTMETERS

GE, AW-41, 2½", rd 0-15 Volt, 800 cycles, rd fl bake case, black scale.
W.H., NA-35, 15 V (100 MA) 3½", rd fl bake case.
Triplett 331-J.P. 3½", rd fl bake case 0-150 volts.

D.C. VOLTMETERS

G.E., DW-41, 15 Volt, black sc, no Caption, sc cal 0-15, 2½", rd fl bake case.
W.H., DX 4½", rd fl metal case 0-150 volts, black scale.

SPECIAL METERS

DeJur Amsco 310, 1 MA sc cal 0-4 KV, 3½", rd fl bake case.
Voltage Polarity Phase Rotation Tester, Triplett 337 AVP. Checks 115, 220 and 440 line voltage; locates open circuits, blown fuses, damaged wiring, etc.; Indicate whether A.C. or DC and polarity of DC; Checks phase rotation to determine direction of rotation of motors, operation of controls, etc.; Consists of a 3" square meter and a small polarized vane movement in a small handy sized case. Complete with 36" leads with test prods.
J.B.T., 30F, Dual range Frequency Meter covers frequency ranges from 48 to 52 cycles; and 58 to 62 cycles: Dual element, Vibrating Reed type, 100-150 Volts, 3½", rd flush metal case.
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ing waves in the supporting element. Under test, a receiving dipole is rotated between the horizontal and vertical positions. The antenna currents are then adjusted in phase and amplitude under the receiver signal indicator reads the same at all dipole angles.

Circular polarization is reported to fill in shadow areas with consistent signal. Another advantage is greater freedom in home antenna installation. For television, the problem of reflected signals is reduced with circular polarization. The TV receiving antenna has a blind tendency to all but the direct path signal.

The NAB one day Engineering Conference closed with a Broadcast Roundtable which covered many diverse points of AM, FM and TV. Panel members included: R. V. Howard, NAB director of engineering as Moderator; O. B. Hanson, NBC, vice-president in charge of engineering; O. W. Towner, technical director WHAS, Louisville, Ky; G. E. Sterling, FCC, chief engineer; J. A. Willoughby, FCC, ass't chief engineer in charge of broadcast; C. B. Plummer, FCC, television broadcast division; J. E. Barr, standard broadcast division; C. M. Braum, FCC, FM broadcast division; G. P. Adair, consultant, Washington, D. C.; D. B. McKey, consultant, Washington, D. C.

SOME NAB EXHIBITS

Alden Products Co., Brockton, Mass.—New facsimile recorder for home use and an 18-in bulletin type recorder in operation recording new broadcasts from WPEN-FM.

Amperex Electronic Corp., Brooklyn, N. Y. —New vacuum capacitors for high powers at frequencies up to 90 mc, as well as a complete line of standard and special purpose tubes.

Andrew Co., Chicago.—New coaxial line equipment and fittings; type 1200 folded Quadropole transmitting antenna.

Collins Radio Co., Cedar Rapids, Ia.—New FM transmitters from 250 watts to 50 kw; an expandable 5 kw FM transmitter which by addition of a tube in a socket provided becomes 10 kw; new 1000/500 20 T AM transmitter; new consoles, one including a newly designed recorder.

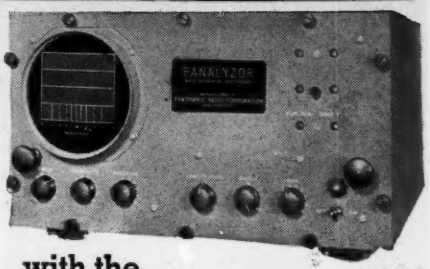
Daven Co., Newark, N. J.—New type multi-leaf switch arm and a complete line of attenuators, selector switches, master controls, fixed pads, transmission measuring equipment; a new wide range volume level indicator and transmission measuring set for FM; new design decade boxes and frequency meters.

DuMont Laboratories, Passaic, N. J.—Packaged television transmission equipment, new image orthicon cameras, a new method of film pick-up, monitoring, studio and remote control equipment.

Eitel-McCullough, San Bruno, Cal.—New 4X125500A3 high frequency, high power air-cooled tetrodes of multi construction combining four tubes in one envelope.

Fairchild Camera & Instrument Corp.,

Simpler FM Analysis



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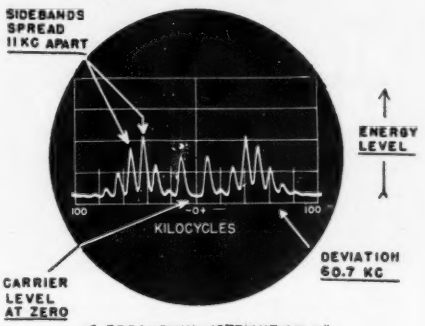
Eliminates tedious, time consuming point by point frequency checks. It shows simultaneously, in one complete picture, an FM'd carrier and resultant sidebands . . . in terms of relative frequency, amplitude and stability.



A single observation enables determination of such performance details as frequency deviation, energy distribution, sideband content, carrier shift and modulation symmetry . . . Operating procedures are simple . . . interpretations clear cut.

Actually, the PANALYZOR is a panoramic spectrum analyzor which shows, distributed in frequency, discrete quantities of r-f energy as vertical deflections on a cathode-ray tube.

Standard models now available with maximum scanning widths of 50 KC to 20 MC and corresponding resolutions of 2.5 KC to 100 KC.

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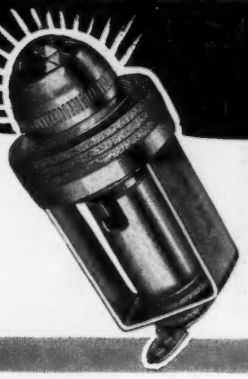

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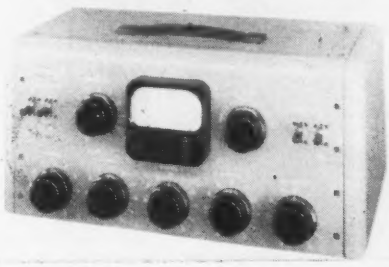
Top, new Collins 2-channel remote amplifier; center, new speech input console; bottom, 1000/500 broadcast transmitter

Long Island City, N. Y.—New sound recording equipment including Unit 542M1 lateral dynamic and Unit 541 magnetic cutter heads; standard recording accessories.

Federal Telephone & Radio Corp., Newark, N. J.—10 kw FM transmitter, console, monitor speaker, transcription table, power supply, FM monitor, transmitting and rectifier tubes and transmission lines; 30-ft. section of the Federal square loop antenna.

Gates Radio Co., Quincy, Ill.—New speech input console; new 1 kw AM transmitter, two new 250-watt AM transmitters, the new 3 kw BF3A FM transmitter; new transcription turnables and desk equipment.



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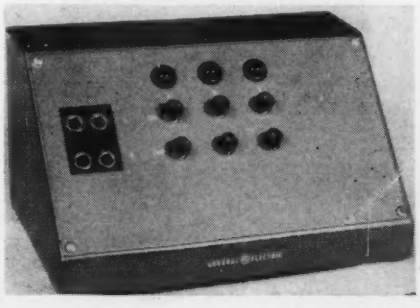
General Electric Co., Syracuse, N. Y.—New 9x5x5 in. announcer's control unit (Type TA-1-C) for television control operations designed to make switching control circuits available to other locations in the studio, and may also be used as a general-purpose control device since all switches, lights, and jacks are wired to a terminal board with no internal interconnections. New streamlined 56 lb. television camera equipped with a three-lens turret and on a mobile dolly. Two handle grips on the unit control all its operations. New desk-

GE's announcer's control unit



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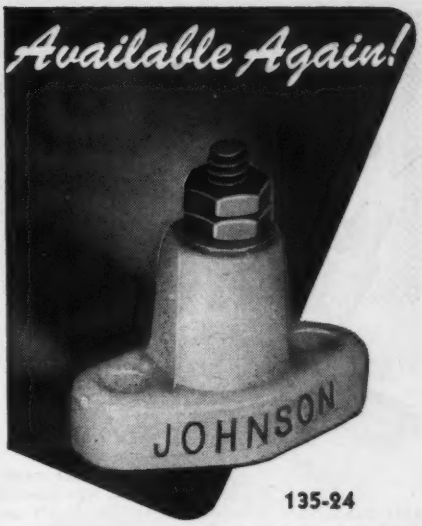

135-24

AND BETTER THAN EVER BECAUSE IT'S STEATITE!

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STEATITE, a highly efficient insulating material, superior in every respect to porcelain, is now also being used in the manufacture of several other standard JOHNSON insulators.

Why is STEATITE better? Because its dielectric losses are but a fraction of that of porcelain!

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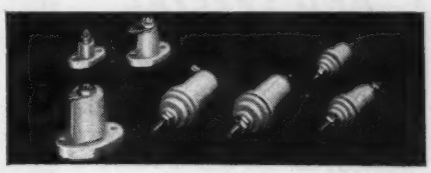

135-20		135-42
135-20J	135-40	135-42J
135-22	135-40J	135-44
135-22J		135-50

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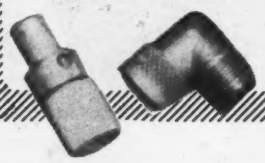

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type television control room program console, containing all the circuits and controls to carry on the necessary supervision and composition of a television program; divided into three sections for the program director, video operator and audio operator. Communication facilities are provided at each position of the console so that directions may be transmitted to studio, projection room, etc.

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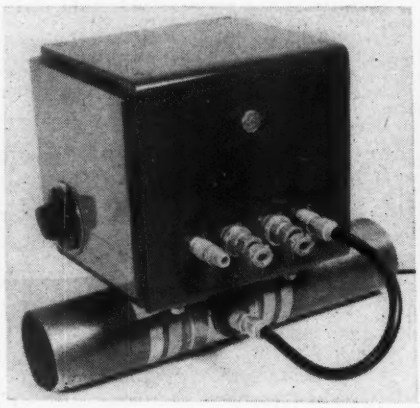
Westinghouse Electric Corp., East Pittsburgh, Pa.—New 3 kw FM transmitter; new exciter and rectifier units for a 50 kw AM transmitter.

Radio Corp. of America, Camden, N. J.—New 10-kw FM transmitter, Type BTF-10B, having new grounded-grid circuits and a new triode (7C24) especially designed for operation at 100 mc. and for grounded-grid operation having a grid structure designed to offer a maximum shielding between the plate and filament, resulting in a very low plate-filament capacity and a high stability of operation; new television visual monitor converter and modulation converter to provide the operator at the transmitter console with a visual image of the picture quality and modulation waveform delivered to the antenna; new Radio-Mike, a combined crystal-controlled, lightweight battery powered miniature UHF transmitter and microphone, especially designed for short distance pick-up work at remote broadcasts; new high-fidelity Duo-Cone monitor loudspeaker, (LC-1A) capable of reproduction over the range from 30 cycles to 15,000 cycles, comprising a 15-in. permanent magnet type mechanism and cones of the direct radiator type with high and low frequency units mounted together coaxially and sharing the same axis and cone periphery angle; new television switching system, (TS-10A), a compact, desk-type control center for push button switching, fading, and lap-dissolving at the camera control position, to provide selection of desired television program material from any one of six video input



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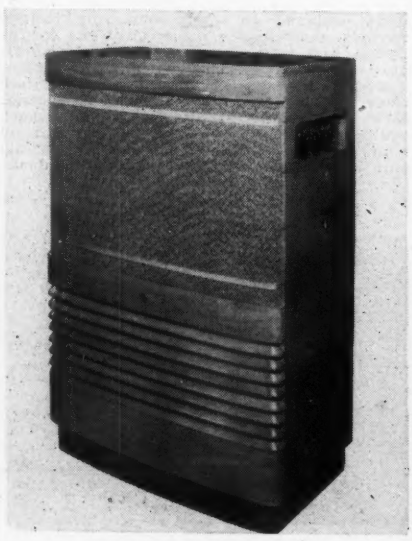

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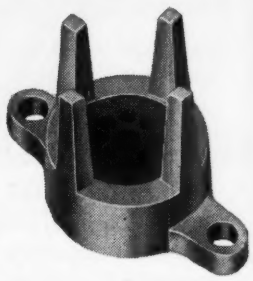

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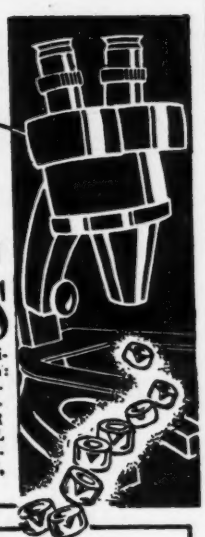

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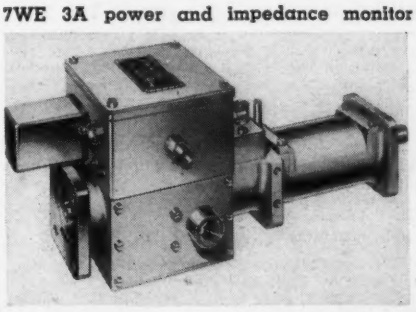

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Of TELE-TECH, published monthly at Orange, Conn., for Oct. 1, 1947, State of New York, N. Y., County of New York, N. Y.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Orestes H. Caldwell, who, having been duly sworn according to law, deposes and says that he is the Editor of TELE-TECH and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Acts of March 3, 1933, and July 2, 1946 (section 537, Postal Laws and Regulations) printed on the reverse of this form, to wit:

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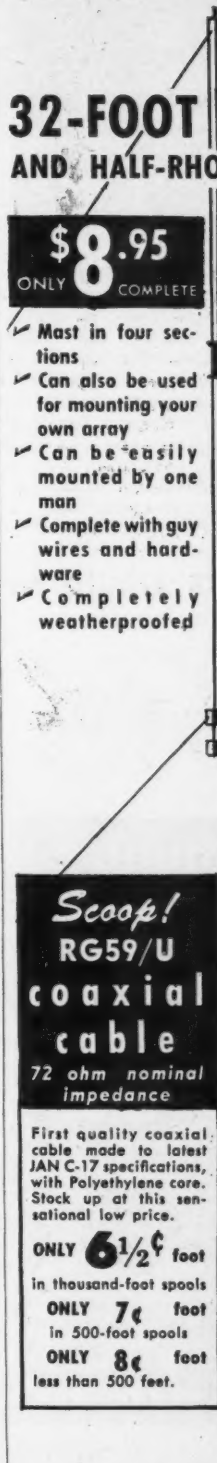

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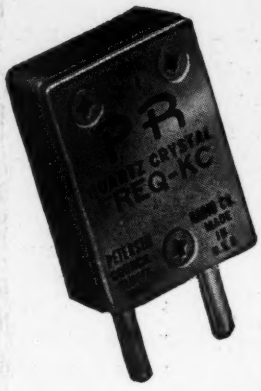

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